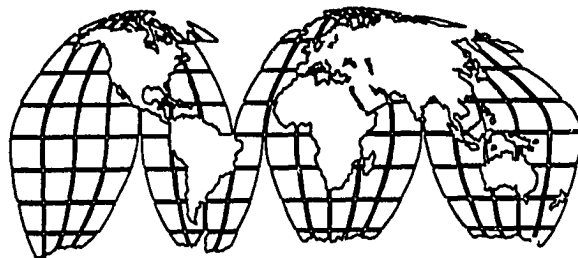


PN-ABU-999
ISN 94861

USAID Working Paper No. 205

Center for Development Information and Evaluation



Forestry and the Environment:
Costa Rica Case Study

November 1994

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

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USAID Working Paper No. 205

**FORESTRY AND THE ENVIRONMENT
COSTA RICA CASE STUDY**

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November 1994

This Working Paper is one of a number of case studies prepared for CDIE's assessment of USAID Forestry and the Environment programs. As an interim report, it provides the data from which the assessment synthesis is drawn. Working Papers are not formally published and distributed, but interested readers can obtain a copy from the DISC.

TABLE OF CONTENTS

| | Page |
|--|------|
| Preface | iii |
| Glossary | iv |
| Map of Costa Rica | vi |
| 1. Introduction | 1 |
| Evaluation Procedures | 2 |
| 2. Background | 3 |
| The Problem | 3 |
| Costa Rica's Forestry Program | 4 |
| The USAID Assistance Approach | 11 |
| 3. Evaluation Findings: Program Implementation | 14 |
| Institution Building | 15 |
| Technological Change | 20 |
| Awareness & Education | 24 |
| Policy Reform | 25 |
| 4. Evaluation Findings: Program Impact | 27 |
| Impact on Practices | 27 |
| Biophysical Impact | 31 |
| Socio-Economic Impact | 34 |
| 5. Evaluation Findings: Program Performance | 36 |
| Program Efficiency | 36 |
| Program Effectiveness | 38 |
| Program Sustainability | 39 |
| Program Replicability | 41 |
| 6. Lessons Learned | 44 |
| Appendices | |
| A. Data Collection and Analysis Methodology | |
| B. A Native Tree Species Research Agenda | |
| C. Persons Contacted | |
| Bibliography | |

PREFACE

The small Central American republic of Costa Rica stands out among developing countries for its "green leadership" in setting aside large primary tropical forest areas as permanently protected habitats for its rich reservoir of biological resources. Equally unique is the innovative spirit with which the country has sought to manage these resources to achieve a win-win outcome of economic development and sustainable natural resource base.

~~Such has not always been the case in Costa Rica:~~ As recently as a decade ago, Costa Rica was being lauded for its efforts at export-led growth, paid for by clearing virgin forests areas to grow crops and graze cattle for international markets. The run-away deforestation of that period continues to this day with a net loss of forest cover still mounting into the tens of thousands of hectares annually. Not until close to the late 1990's is net deforestation expected to be halted, and only then because remaining unlogged areas are too poor for agricultural activity and too inaccessible for tree extraction.

Still, some promising strategies have emerged from the forested "front lines" of the country's conservation movement and organized efforts to manage remaining natural forests. This evaluation examines the impact and performance of those strategies which USAID has helped develop and implement in Costa Rica.

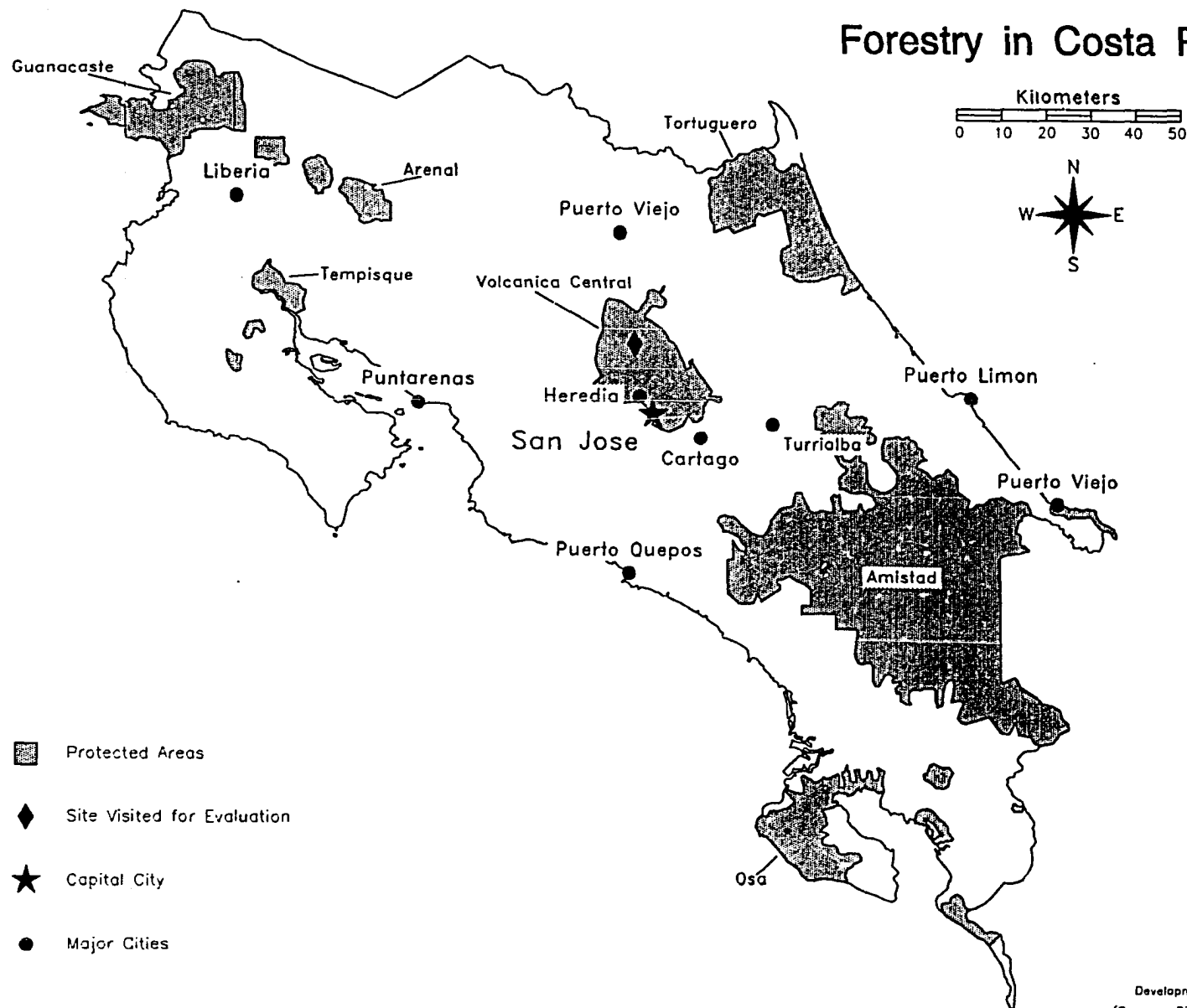
The Costa Rican experiment is one of the few cases that give cause for hope that sustainable development can indeed be achieved. If a win-win outcome cannot be achieved in Costa Rica, with all its advantages of high literacy rates, strong democratic institutions and extensive linkages with the international conservation community, then there seems little hope for many other less well positioned developing countries.

There is a danger, however, that with its successes so far, Costa Rica may prematurely be declared a victory by the international community and left to its own devices as attention turns to other needy areas. This evaluation is dedicated to emphasizing both the contributions made by the Costa Rican program as well as to warning that the war is far from won. Much remains to be done to consolidate early successes, win the hearts and minds of those affected and build defenses against forces that can still reverse the modest gains made so far.

GLOSSARY

| | |
|----------|--|
| ACCV | Central "Cordillera" Volcanic Conservation Area |
| BOSCOSA | Program for Forest Mgt and Conservation of the Osa Peninsula (USAID) |
| CACSA | Cantonal Agricultural Center for Sarapiquí |
| CATIE | Tropical Agricultural Center for Education and Research |
| DGF | General Forestry Directorate |
| FAO | Food and Agricultural Organization |
| FORESTA | Forest Resources for a Stable Environment Project (USAID) |
| FUNDECOR | Foundation for the Development of the Central Volcanic Cordillera Region |
| GOCR | Government of Costa Rica |
| IDB | Inter-American Development Bank |
| MADELENA | Timber and Fuelwood Program (USAID) |
| MAG | Ministry of Agriculture |
| MIRA | Information System for Tree Resources |
| MIRENEM | Ministry of Natural Resources, Energy and Mines |
| NGO | Non-governmental Organization |
| NRMP | Natural Resources Management Project (USAID) |
| OTS | Organization for Tropical Studies |
| ROCAP | Regional Office for Central America Programs (USAID) |
| SINAC | National Conservation Areas System |
| SPN | National Parks Service |
| USAID | United States Agency for International Development |
| USFS | United States Forest Service |
| WRI | World Resources Institute |

Forestry in Costa Rica



Development Alternatives, Inc. (1994)
 (Sources: Digital Chart of the World & IUCN)

1. INTRODUCTION

Forests literally hold the Central American nation of Costa Rica together, physically and economically. Over the millennia forests evolved and spread across the loose unstable volcanic mountain range that extends the length of the country. The growth and decomposition cycle of forests built up the rich piedmont and coastal alluvial soils that today are the basis for the country's agricultural economy. Forested watersheds prevent the heavy tropical rains from washing the country's thin rich topsoil into the sea. Costa Rica's forests are also habitats for an estimated 7 percent of the world's biological resources (IUCN 1992). Trees harvested from Costa Rica's forests supply wood products industries, contribute to export earnings and generate local jobs.

For the last two decades, however, Costa Rica has been on a collision course with environmental and economic disaster. Costa Rica is harvesting trees from its forests faster than they are replaced. It is consuming its natural forest assets, destroying watersheds from which electric power and potable water are drawn, depleting wildlife habitats and driving its biological resources towards extinction. Past economic growth policies have been singled out as the culprits (Bradley 1990 and MIRENEM 1990). New programs aimed at sustainable economic growth have been formulated, but are far from being fully implemented. Runaway deforestation continues.

This report assesses the performance and impact of one assistance approach used by the U.S. Agency for International Development (USAID) to help Costa Rica conserve and sustainably manage the country's forest resources. The approach involves the creation of an environmental NGO and a trust fund to finance the management and oversight of the national parks and the reforestation and sustainable management of surrounding forest areas unsuitable for agriculture in Costa Rica's central volcanic highlands. (A separate CDIE report examines USAID support for protection of biological diversity in Costa Rica.)

Section 2 of this report describes the problems threatening forests in Costa Rica and the approach that USAID has taken to resolve them. Sections 3, 4 and 5 discuss the evaluation findings on the program's implementation, impact, efficiency, effectiveness, sustainability, and replicability. Section 6 summarizes lessons learned from the evaluation.

The Costa Rica case study is part of a global assessment of social forestry programs. Other country program assessments include The Philippines, Pakistan, Nepal, The Gambia, Mali and Ecuador.

Evaluation Procedures

CDIE consulted a variety of primary and secondary sources of data and information to construct the chain of events linking USAID assistance activities to observed program impacts and performance and to identify lessons learned. (See Appendix A: "Evaluation Methodology").

In preparation for the field work, CDIE collected and analyzed relevant secondary information available in Washington, D.C. and in the host country from a range of sources including project papers, reports, special studies, and evaluation documents. In Costa Rica, the assessment team reviewed USAID project document files and reports prepared by host-government agencies, private voluntary organizations, USAID contractors, and international donor institutions.

The CDIE field team also conducted extensive key informant interviews to obtain data, ideas and insights into events and actions from a range of project participants and knowledgeable people. Questions were based on an interview guides developed prior to the country field work. Respondents included government officials and technicians, buffer zone land and forest owners, and representatives of international agencies, local NGOs, private tourism operations, and universities (See Appendix D: "Persons Contacted").

CDIE selected Costa Rica's central "cordillera" region, and its parks and surrounding buffer areas, for intensive examination because they the region combines several conditions that highlight the agriculture development and forest conservation nexus in Costa Rica. These interventions provide the opportunity to examine the impact of USAID and Costa Rican government efforts to establish a biologically and institutionally sustainable system for the management and use of forest resources as part of national economic growth and development.

2. BACKGROUND

The Problem

Costa Rica is internationally recognized as one of the world's most progressive developing countries by a number of economic and social indicators. Rising income per capita, high literacy and low infant mortality are a few of the socio-economic measures that set Costa Rica apart among developing countries. Even the share of land the country sets aside for the protection of wildlife habitats -- about one in every ten hectares of land area -- ranks very favorably with developed nations.

Despite impressive economic and social performance, environmental degradation in the form of rapid deforestation, and associated biodiversity loss, threatens Costa Rica's long-run economic performance. In fact, when allowance is given for the rates at which Costa Rica has been consuming its "inventory" of natural and forest resources, the country's rates of economic growth are much lower (Solorzano, et al. 1991). From an area of 26,000 square kilometers, covering more than half of the country in 1970, forests have been reduced to only 13,230 square kilometers covering one fourth of Costa Rica in 1987. Until recently, deforestation has proceeded at rates estimated between 50,000 to 60,000 hectares of forest land lost annually (MIRENEM 1990).

With the depletion of the forests, it is estimated that by the end of the century the annual import bill for wood could range from \$50 million to more than \$200 million -- a financial situation which would reverse any macroeconomic gains Costa Rica will have gained from stabilization efforts (MIRENEM 1990). Less than 30 percent of the country's territory is considered appropriate for even the most limited agricultural activity. Yet, over 60 percent of its land base is used for agriculture, pasture, or urban development.

Deforestation also threatens Costa Rica's biological diversity. The runaway destruction of forests for crop cultivation and cattle grazing is putting pressure on the 13% of Costa Rican land area (687,110 ha) which is protected as critical habitats essential for maintenance of the country's biodiversity. Today, most of these forest habitats stand as isolated "biological islands" surrounded by expanses of degraded secondary forest, pasture and commercial agriculture. Their small size and fragmentation raise questions about the long-run viability of the genetic resources they contain.

The principle cause for this widespread deforestation is not only the demand for timber but also the large-scale demand for

agricultural land, a scarce commodity in a country marked by steep slopes, unstable soils, and heavy rainfall. Trends in land use over the 20-year period 1970-90 reveal the steady loss of over 1.5 million hectares of forest land and an almost equal expansion of pasture area. (See Figure 1). During this period Costa Rica's environmental story was, in large measure, one of "converting trees into hamburger" to satisfy the world's demand for beef and to fuel the country's ambitious export led development strategy that promoted beef production for sale in international markets.

Costa Rica's Forestry Program

Costa Rica's forestry action plan sets goals for halting net deforestation and for restoring forest cover to about 40 percent of the country's land area (MIRENEM 1988). Measures taken so far have been largely regulatory in nature -- a ban of log exports, required permits for tree harvesting on any lands, public or private. In 1987 the government introduced a reforestation subsidy (CAF) to encourage tree planting and budgeted programs for more efficient use and processing of timber products.

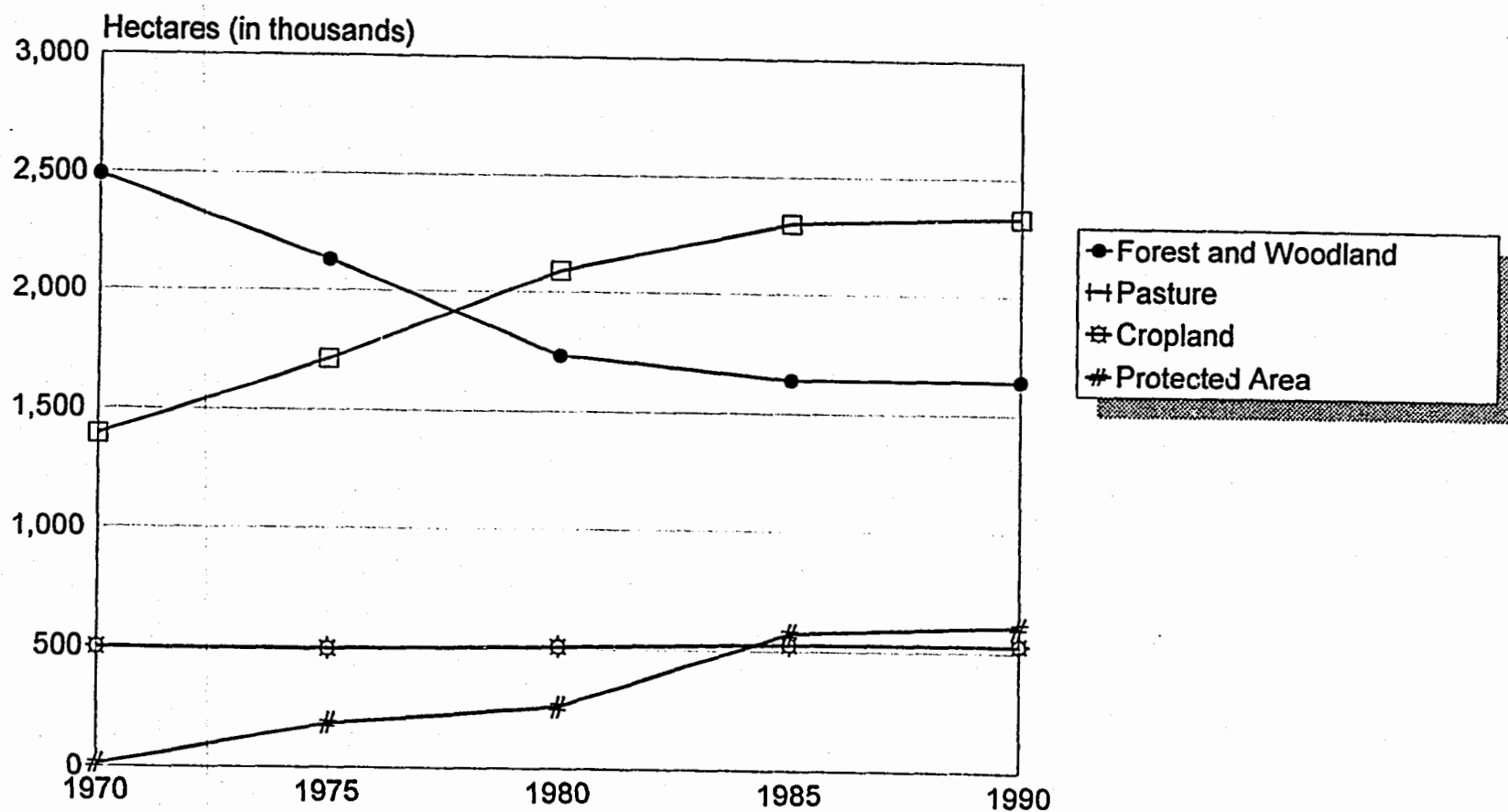
Policies aimed at regulating forest use have, in practice, created perverse incentives that have worked against forest conservation goals. Log export bans, for example, have caused the value of timber to fall, reducing the value of standing forests and fostering the clearing and "improving" of land for agriculture and livestock grazing. The skeletal remains of majestic hardwood species strewn across pasture land -- because it was not even profitable to remove them for sale -- attest to the perverseness of past forest conservation policies. Standing forests managed for their sustainable use remain rare today in a country that has gained international respect for its "green" policies.

Recent Costa Rica administrations have tried to undo the damage of past misguided, if well-intentioned, forest policies. In 1989, the Costa Rica Government of Costa Rica devised a National Conservation Area System (SINAC) approach to Costa Rican forest and wildland management in order to consolidate protected area conservation and contiguous forest management, meet the socio-economic needs of the local communities, and serve other Costa Rican national and international interests. The broad objectives of the new conservation area system include the maintenance of ecological processes of natural ecosystems, preserving genetic diversity, and permitting sustainable harvest of plant and animal species of these ecosystems (MIRENEM 1990).

Specific objectives of SINAC include:

- establishing endowment funds for each conservation area to ensure long-term financing;

Figure 1: Costa Rica - Land Use (1970-1990)



Source: FAO 1987; IUCN 1990b; WRI 1992b

Note: Forest and Woodland, Pasture, and Cropland data are from 1971, 1976, 1981, 1986, and 1989.

Protected Area data are from 1970, 1975, 1980, 1985, and 1990.

- decentralizing government agencies, to give each conservation area more decision-making authority and management autonomy;
- establishing financial and administrative systems with the involvement and participation of NGOs;
- involving community participation in different activities within the system as an element to promote local stewardship of the natural resource base among communities adjacent to the conservation areas.

SINAC groups forests and wildlands within seven major Conservation Areas: La Amistad, Arenal, Osa, Guanacaste, Tempisque, Tortuguero, and Volcanica Central (MIRENEM 1994). (See Table 1).

Table 1: Costa Rica's Conservation Areas

| <u>Conservation Area</u> | <u>Nucleus Area</u> | <u>Marine Area</u> |
|--------------------------|---------------------|--------------------|
| Amistad | 273,451 Ha. | 22,400 Ha. |
| Arenal | 2,920 " | |
| Osa | 57,548 " | 7,775 " |
| Guanacaste | 161,713 " | |
| Tempisque | 21,378 " | |
| Tortuguero | 18,946 " | 52,265 " |
| Volcanica Central | 71,551 " | |
| Total | 607,507 Ha. | 82,440 Ha. |

Source: MIRENEM 1993

The conservation areas are groups of contiguous or clustered lands placed in one of several management categories depending on their bio-physical features, socio-economic characteristics and regional relationships. Each conservation area may include one or more core or nucleus areas, consisting of one or more existing protected areas such as national parks, managed for biodiversity conservation, plus surrounding buffer zones for sustainable development activities. Governmental wildlands (forest reserves, wildlife refuges, and protected areas) or private lands adjacent to the core areas serve as buffer zones where sustainable uses of natural resources are promoted, including controlled timber or firewood extraction, wildlife management, and nature tourism. (See Map of Costa Rica).

Each conservation area has its unique characteristics and needs, which call for independent administrative bodies. The Costa Rican Government has the legal authority for management and decision-making in the conservation areas, while non-governmental

organizations (NGOs) play an important role in actual development and implementation. Each conservation area has a regional advisory commission, made up of local community representatives and GOCR agency staff detailed for its administration and management. At the time of this evaluation, a multi-agency configuration of institutions had jurisdiction over the protection and management of Costa Rica's conservation area system. (See Table 2: Administrative Responsibilities for Costa Rica's Conservation Areas).

Table 2: Administrative Responsibilities for Costa Rica's Conservation Areas

| <u>Government Agency</u> | <u>Category</u> | <u>Number</u> | <u>Area (Ha)</u> | <u>%</u> |
|--------------------------|---------------------|---------------|--------------------|---------------|
| Park Service (SPN) | National Parks | 19 | 501,704.5 | 44.63 |
| | Biological Reserves | 8 | 17,653.3 | 1.57 |
| | National Monument | 1 | 217.9 | 0.01 |
| SUBTOTAL | | 28 | 519,575.7 | 46.22 |
| Forestry Dpt. (DGF) | Protected Zone | 29 | 187,897.9 | 16.71 |
| | Forest Reserve | 9 | 303,385.4 | 26.99 |
| SUBTOTAL | | 38 | 491,283.3 | 43.71 |
| Wildlife Dpt. (DVS) | Wildlife Refuge | 8 | 113,098.5 | 10.06 |
| TOTAL | 6 Categories | 74 | 1,123,957.5 | 100.00 |

Source: MIRENEM 1994

The director of a conservation area oversees forest and wildland management within the geographical boundaries of the conservation area. Legally, however, these areas remain under the authority of the SPN, DGF, DVS, and the Costa Rican Institute of Electricity (ICE). A law proposed in the Costa Rican Legislative Assembly in June of 1991, created SINAC within the MIRENEM.

Although the legal base which formalizes the organizational, administrative and financial policy is still to be promulgated by the legislative assembly, MIRENEM has already begun implementing many aspects of SINAC (Vaughn 1994).

The Central "Cordillera" Volcanic Conservation Area (ACCVC) is one of the seven SINAC areas. A Regional Committee comprised of local community members and MIRENEM staff and a Technical Committee advise the ACCVC Director. There are four program areas within the ACCVC: protection, research, education, and land tenure. (See Figure 2).

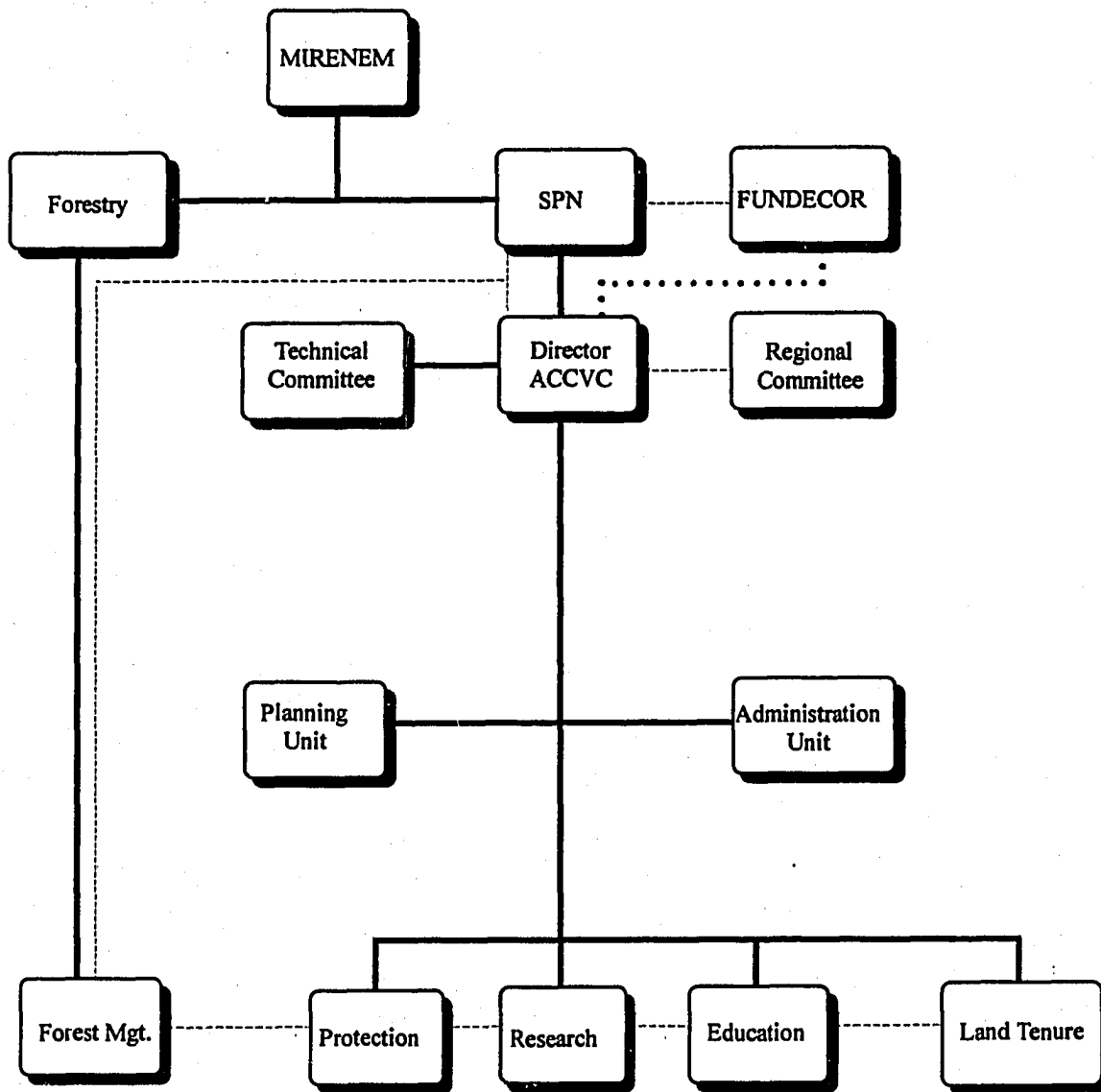
Human activity -- notably farming and cattle raising -- is found throughout the conservation area resulting in a patchwork of forested and agricultural lands. The Costa Rican government has banned any further hunting or logging on lands -- public or private -- within the official park boundaries and must approve all logging activities on private lands in the conservation area. The national park service attempts to control abuse of forests within the parks, and the DGF has responsibility for regulating forest use and for promoting forest management and plantation forestry on private lands elsewhere in the ACCVC. However, where private lands still have not been purchased by the government, where land titling is in dispute, or simply, where poachers feel they can get away with it, illegal hunting and logging continue on a regular basis.

The ACCVC contains some of the largest blocks of primary forest remaining in Costa Rica and has several unique features both in its natural resources and in the way they are managed and protected. Physically, the region has three volcanic parks which are unique geological attractions for tourists. Poás and Irazú National Parks are Costa Rica's top tourist attractions, while the Turrialba site has yet to be developed for tourism. The ACCVC has one park, Guayabo, around an archeological site of cultural significance and it has two additional parks (Juan Castro Blanco and Braulio Carillo) composed largely of primary forests with some successional growth where human activity once occurred. (See Figure 3).

Most of these protected areas are of recent vintage, being legally constituted in the last two decades and in some cases still supporting human activity, farming, cattle raising within their borders where land has not yet been purchased by government. The GOCR has banned any further hunting or logging on lands -- public or private -- within the official park boundaries and assigned the national park service to enforce the regulation. However, where private lands still have not been purchased, where land titling is in dispute, or simply where poachers feel they can get away with it, hunting and logging continue on a regular basis.

Figure 2:

Central Volcanic Cordillera Conservation Area
Proposed Administrative Organization



Source: MIRENEM

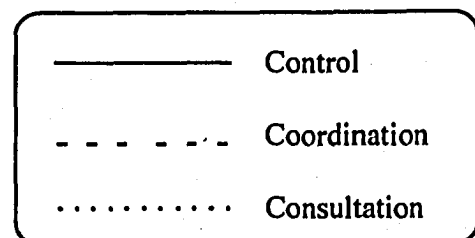


FIGURE 3
CENTRAL CORDILLERA VOLCANIC CONSERVATION AREA

| ACCVC Land Use | |
|-----------------------|-------------------|
| National Parks | 71,551 ha |
| Buffer Zones | |
| Forest | 102,402 ha |
| Other | 116,234 ha |
| Total Area | 290,187 ha |

National Parks

- 1 Braulio Carrillo
- 2 Volcán Poás
- 3 Volcán Irazú
- 4 Volcán Turrialba
- 5 Juan Castro Blanco

National Monuments

- 6 Guayabo

Forest Reserves

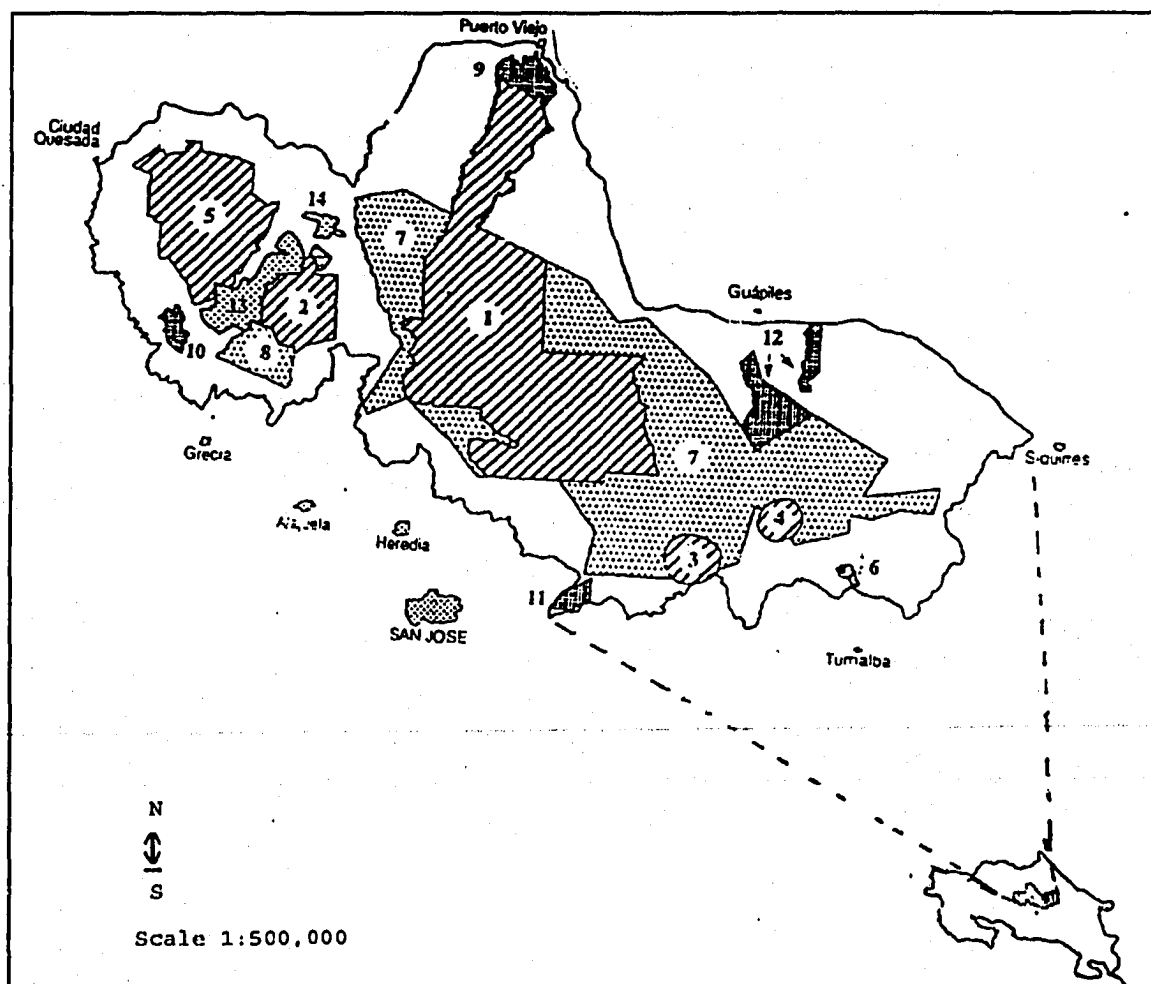
- 7 Central Cordillera Volcanic
- 8 Grecia

Protected Areas

- 9 La Selva
- 10 Chayote
- 11 Río Tiribí
- 12 Acuíferos Guácimo Pococi
- 13 Toro

Wildlife Refuges

- 14 Vida Silvestre Bosque Alegre



The USAID Assistance Approach

Support for Costa Rica's export led growth was the focus of the USAID development strategy in Costa Rica through most of the 1970s and 1980s. In 1979, USAID included the sustainable management of the country's natural resources base, particularly its forests, as an additional dimension of its development program. This revised development strategy recognized that runaway deforestation was threatening the water supply and hydroelectric power, destroying wildlife habitats and moving Costa Rica toward being a net wood importer before the end of the century (USAID 1989). The USAID strategy targeted improved management of national parks as well as contiguous commercial forests (buffer zones) in an effort to achieve a win-win balance between economic development and natural resource conservation.

The first major USAID initiative to implement its new strategy was the Natural Resources Conservation Project (1979-1987), which spanned a range of forestry and park protection activities. While the Natural Resources Conservation Project did not meet all of its objectives, its accomplishments in forestry training and policy reform have built a foundation for subsequent initiatives.

More recently, USAID has supported Costa Rica's efforts at managing its expanded protected system through a number of project initiatives. USAID authorized a \$1.0 million Forest Conservation and Management (BOSCOSA) Project (1990-93) to promote sustainable forest development in the buffer zones surrounding Costa Rica's Corcovado National Park in the Osa peninsula. USAID has given smaller grants to U.S. and Costa Rican NGO's for the management of the private Monteverde Cloud Forest Reserve and the Tortuguero, Corcovado, Talamanca and La Amistad National Parks, and for implementation of the Paseo Pantera regional biodiversity program.

The most ambitious initiative in USAID's revised development assistance strategy in Costa Rica -- and the focus of this evaluation -- is the \$7.5 million Forest Resources For a Stable Environment (FORESTA) project (1990-96). USAID and the Costa Rican government designed FORESTA as a regional effort to support ecologically sound long-term economic development of the parks and buffer zone areas in Costa Rica's central volcanic "cordillera" region. The Costa Rican government is contributing an additional \$10.0 million in local currency, under a USAID debt forgiveness program, to capitalize an endowment that will provide ongoing financial support to a Costa Rican NGO, Foundation for Development of the Cordillera Region (FUNDECOR), created to carry out FORESTA activities.

A major FORESTA objective is the protection of biological resources within the newly created ACCVC conservation area boundaries. FORESTA will accomplish this by enhancing the

MIRENEM's financial and administrative capacity to monitor and enforce forest and park use regulations and by educating and motivating -- through employment and investment incentives -- members of local communities in conservation areas to respect those regulations. FORESTA also promotes reforestation and natural forest management as economically and ecologically appropriate land uses in the buffer zones around the Braulio Carillo, Poás, and Irazú National Parks as well as other natural protected areas of the Central Cordillera (USAID 1989a).

FORESTA operates through a newly created independent non-government organization, FUNDECOR, to provide direction, technical assistance, coordination and funding for a) the management of the national parks and other natural protected areas in the Central Cordillera, b) promotion of reforestation and sustainable use of natural forests, and c) assisting farm households to increase incomes and to improve the quality and value of their land by integrating trees into their production systems (USAID 1989a).

Components of the FORESTA project include: 1) general operations, 2) management of protected areas, 3) management of natural forests for production, and 4) introduction of trees, reforestation, and agroforestry, on farms.

The FORESTA "General Operations" component provides technical assistance and funding to FUNDECOR as a permanent, private, non-profit entity to carry out project activities over the long term under the general guidance of the MIRENEM. The GOCR is arranging with USAID to set aside local currency loan repayments to pay core FUNDECOR operating expenses after FORESTA completion on January 30, 1996. Under the general operations component, FUNDECOR:

- develops overall plans and guidelines for the Central Volcanic Cordillera and strengthens the administrative organization to carry out these plans;
- manages and monitors all FORESTA project components and reports on their performance;
- contracts for outside technical assistance services needed to support FORESTA and MIRENEM operations;
- secures other sources of donor support for activities in the ACCVC conservation area.

Under the FORESTA "Management of Protected Areas" component FUNDECOR is improving habitat and wildlife conservation by:

- helping the ACCVC to develop park management plans, demarcating park boundaries, acquiring land from owners located inside the newly demarcated park boundaries, improving park protection programs, building tourist

infrastructure and contracting for park visitor service operations from communities bordering the parks;

- assisting MIRENEM to establish regulations for directing all income earned from ACCVC park visitors to pay for improvements and operation;

Under the FORESTA "Natural Forest Management" component FUNDECOR works to halt further destruction of natural forests by:

- developing guidelines for sustainable logging of natural forests by contracting and advising individuals as well as farmer groups (cooperatives, associations) in the creation and execution of management plans for minimum impact road construction, tree felling, tree extraction, and other silvicultural interventions (eg. thinning);
- working with the DGF to simplify procedures for preparation and approval of natural forest management plans and, where necessary, with land owners to obtain titles to the forested land they wish to manage.

Under the FORESTA "Trees on Farms" component, FUNDECOR works to restore degraded forest and agricultural lands by:

- identifying and promoting the use of native tree species in reforestation;
- working with the DGF to simplify the procedures for preparing and processing reforestation plans;
- assisting land owners in obtaining titles and preparing and getting approval for reforestation plans;
- contracting and advising nursery operators in the collection of seed, propagation of seedlings and the production of planting materials for reforestation.

This evaluation report focuses on measures that USAID and the GOCR have employed under the "Forest Management" and "Trees on Farms" components of the FORESTA project, to protect biological diversity. The park management component of the FORESTA project is the subject of a separate evaluation report, "Bio-Diversity Protection Programs: Costa Rica Case Study" that explores in more detail the impact and performance of strategies employed for sustainably managing forest habitats.

3. EVALUATION FINDINGS: PROGRAM IMPLEMENTATION

This evaluation examines four strategies as determinants of forest management programs receiving USAID support. See Appendix A for further discussion. The four strategies are:

- **Institution building** -- strengthening local and national level public agencies and non-governmental organizations to carry out programs aimed at sustainable forest management;
- **Technological change** -- introducing new practices and techniques for sustainable forest management;
- **Education and awareness** -- increasing local and national knowledge and understanding of the value of managing forests in a sustainable fashion; and
- **Policy reform** -- enhancing economic and other incentives for sustainable forest management.

FORESTA employs each of these strategies in the implementation of the reforestation "trees on farms" and natural forest management components of the project to halt loss of natural forests and to restore forest cover to lands that have no other sustainable economic use in the Central Volcanic "Cordillera" Conservation Area (ACCVC) of the country. Moreover, other elements of the USAID assistance program in Costa Rica have employed these strategies to halt deforestation elsewhere in the country -- e.g., the USAID REFORMA project efforts to reform and implement forest policy. This section examines the conditions created to support ACCVC forestry goals through FORESTA.

At the time of the evaluation a multi-agency configuration of institutions had jurisdiction over protection and management of the environment and natural resources within the ACCVC. In turn these agencies formed part of an emerging national system of seven conservation areas into which proposed 1989 legislation divides the country.

The forestry objectives of FORESTA are to halt the loss of primary forests in buffer zone areas and promote the reforestation of other ACCVC lands not suitable for agriculture and human settlement. ACCVC land use plans have identified areas most prone to deforestation as priorities for concentrating natural forest management efforts.

Institution Building

By fostering creation of FUNDECOR, the FORESTA project has defined a new role for NGOs in working with the Costa Rican government to manage the country's forests.

USAID has worked with the Costa Rican government in the design of FORESTA to create a private regional development foundation responsible for carrying out what have traditionally been public sector forest conservation tasks. Small privately managed commercial tree plantations, limited to specific tree production activities are common in Costa Rica. The Costa Rican government has agreed to FUNDECOR participation in the planning and management of all forest resources within the entire area of one of the country's new conservation zones, the "cordillera central" region of the country. As a legally constituted NGO, FUNDECOR can contract to provide forestry services and receive income to cover the costs of its operations.

FUNDECOR functions as a partner and promoter of sustainable commercial forest management among land owners, avoiding the adversarial role associated with the General Directorate of Forestry (DGF) policing forests for illegal logging. The partnership role is evidenced by FUNDECOR's progress in developing reforestation plans and contracts with land owners seeking to plant trees on their farms or to conduct limited sustainable timber extraction from standing primary forest. FUNDECOR contracts with owners of natural forest span a range of activities from assistance in obtaining titles without clearing, or "improving", the forest, to participation in an ecotourism enterprise, to carefully controlled sustainable logging. In return for FUNDECOR's assistance, landowners agree to reimburse FUNDECOR for its direct costs and to sustainably manage their forests over the life of the contract. As of December 30, 1993, FUNDECOR records show it had developed and received approval of plans for reforestation of 435 hectares and had signed agreements with the owners of 8,700 hectares of natural forest.

FUNDECOR promotes sustainable economic development and job creation within the ACCVC through the promotion of natural forest management and reforestation. It functions as a cross between a regional development agency, an integrated forest consulting firm, and a credit agency. FUNDECOR has promoted and financed the development of three private sector nurseries in Sarapiquí. The owner of one of these nurseries is now also contracting to plant trees in the ACCVC area and elsewhere in the Northern and Atlantic Zones of Costa Rica and has formed an association of reforestation workers. FUNDECOR also prepares reforestation and forest management plans for private landowners, obtains DGF approval of the plans, and oversees and finances their implementation.

The FORESTA project also calls for FUNDECOR to establish at least one forest enterprise integrating sustainable forest management with wood processing and management. However, the team found that FUNDECOR had examined several possibilities, but apparently had neither the staff nor the financial resources to undertake such a task so early in its development as an organization. Moreover, the FUNDECOR board decided that it was not interested in establishing an industry to compete with established industries. Considering the cost involved and the difficulty of organizing a group of landowners, many of whom are not resident in the zone, to develop a vertically integrated industry. With an annual budget of only the local currency equivalent of \$400,000), FUNDECOR's decision appears to have been a wise one. While FUNDECOR has not made progress on the establishment of a wood processing enterprise, it has been responsible for creating two nurseries and one reforestation enterprise, for improving the practices of reforestation and logging contractors, and for developing a nature tourism proposal which will increase the value of the forest to the owners of approximately 20,000 hectares of forest land in the ACCVC.

With only a few exceptions, FORESTA support has been sufficient for meeting FUNDECOR's forest management and reforestation program administration and planning needs.

The evaluation team found that equipment, vehicles and supplies funded under FORESTA met much of the ACCVC and FUNDECOR's operating needs. The only complaint heard (frequently) was about the limitations of the USAID funded vehicles of US origin which were not suitable for some of the remote working conditions. The relatively low clearance of these vehicles made them unsuitable for reaching some of the reforestation and natural forest management sites and slowed down the promotion and supervision work of FUNDECOR staff. While not a problem at current work volumes, an expansion of FUNDECOR activities to levels anticipated by the time the FORESTA project ends could begin to impose constraints on operations both from the cost and timing allocation standpoints. Maintenance of vehicles of U.S. origin is also a problem since U.S. manufacturers do not provide adequate service and parts support in Costa Rica.

Through FUNDECOR, FORESTA has strengthened the capacity of local agricultural and farm groups to carry out reforestation with native species.

The project calls for FUNDECOR to assist in the consolidation of one or more organizations in the ACCVC and to help these organizations develop agro-forestry projects. The team found that FUNDECOR is supporting the revitalization of small farmers' groups in the Cantons of Sarapiquí and Siquirres, but that neither these

organizations nor FUNDECOR are making significant progress with the introduction of agro-forestry systems.

FUNDECOR provides technical and financial assistance to two small farmers' groups in the ACCVC, the agricultural center for the canton of Sarapiquí (CACSA) and the agricultural center for the canton of Siquirres (CACSI). FUNDECOR staff report that when the foundation began its operations in Sarapiquí, CACSA was so poorly organized and administered that it was about to lose its status. At the same time, FUNDECOR developed a reforestation strategy to focus its efforts on areas larger than 5 hectares and to assist CACSA in developing a reforestation program for small landowners.

FUNDECOR now provides assistance to strengthen the administrative and technical capacity of CACSA. A FUNDECOR representative serves on the CACSA board of directors. FUNDECOR contracted a forester to work with CACSA for one year. Unfortunately, CACSA was not able to assume responsibility for a forester's salary after a year, and a FUNDECOR forester is now providing assistance to CACSA staff and clients. FUNDECOR also financed the hiring of an administrator for CACSA and arranged for CACSA to receive a donated Macintosh computer and printer from the Pan American Development Foundation (PADF). FUNDECOR provided CACSA with a phone, files, and a FAX and arranged for reforestation training for CACSA staff in Costa Rica and Nicaragua.

Box 1: Building New Programs on Progress from the Past

The cantonal agricultural centers (CACs) are quasi-governmental organizations of small farmers which received support from USAID agricultural projects in the 1970s and early 1980s. Now spread throughout the country, CAC's are based on a model originally developed in Turrialba, an agricultural center and headquarters of the Latin American Center for Agricultural Technology, Research and Training (CATIE). The original Turrialba CAC was very successful in extending technologies for honey farming, fish farming, agro-forestry, etc. and providing an organizational base to allow small producers to benefit from the processing and marketing of their products.

CACs receive their financing from membership dues and, in the case of forestry activities, a forestry subsidy over 5 years for every hectare reforested with assistance from the CAC.

FUNDECOR has also provided technical and financial assistance to CACSA to develop its nursery and plans to provide one more year of financing for the CACSA nursery operation. FUNDECOR provides

funds and/or in-kind assistance for CACSA to purchase seed and other nursery supplies and recoup its costs when the trees are planted and the reforestation subsidies are paid.

During the coming year FUNDECOR plans to provide similar assistance to CACSI. FUNDECOR has already financed the preparation of reforestation plans for a group of CACSI members who will reforest 50 hectares and has also provided training for the CACSI director. FUNDECOR has also provided assistance to other community organizations and municipalities in developing tree planting activities in the ACCVC.

FUNDECOR is drawing upon and supporting networks of research organizations that are serving to address some of the technical problems facing management of natural forests and reforestation with native tree species.

As a new organization, FUNDECOR has had to draw on past experience from a number of sources. At the outset, FUNDECOR staff and management had little knowledge about the establishment and management of native species plantations or the various processes and technologies which they have combined to create an innovative and very promising natural forest management program. Land use planning and management tools, such as geographic information systems, were also new technologies.

FUNDECOR staff turned to a number of institutions and their information networks to acquire needed information about reforestation and forest management technologies. The Costa Rican setting is relatively rich with organizations that have information and experience to support FUNDECOR's forestry program.

One of the institutions best positioned to be of help to FUNDECOR is the Organization of Tropical Studies (OTS), which for several years has operated a research station "La Selva" within only a few miles of FUNDECOR's field offices in Sarapiquí. Particularly valuable to FUNDECOR has been earlier OTS native tropical tree species propagation and growth research. Through OTS and other research institutions such as CATIE and the Costa Rican Technological Institute (ITCR), FUNDECOR has obtained invaluable information that made it possible to launch its reforestation program using native tree species.

FUNDECOR participates, as a founding member, in a nationwide native species group which the ITCR has organized. This group is working to organize available information on native species and identify research needs. FUNDECOR has provided funds to support research by OTS (selection of seed trees and phenology studies) and by students from CATIE and ITCR.

OTS, in turn, counts on FUNDECOR as part of its community outreach work and as a vehicle for the applied testing of its research findings. So complementary is the FUNDECOR and OTS relationship that the FUNDECOR director was invited to join the OTS technical advisory board. In addition to OTS, FUNDECOR has sought to draw on forestry research and development networks such as those sponsored, in part with USAID money, by CATIE for the Central American region.

It is to FUNDECOR's credit that it has invested in building relationships with existing research networks to obtain information needed in its programs. These linkages have made it possible for FUNDECOR to concentrate on promotion and development activities and save tremendous amounts of time and money that otherwise would have been required to undertake a research program of its own.

FORESTA has drawn on basic and applied biological and forestry research carried out by scientists associated with OTS, CATIE, and ITCR, but so far FUNDECOR has not worked with these or other organizations to define the natural resource management research and monitoring needs for the ACCVC, develop a research and monitoring program of identify funding for the program.

Scientists at the Organization of Tropical Studies (OTS) La Selva facility, in collaboration with the DGF began research on native species plantations in the early 1980s with a seed grant from the Canadian government. The John D. and Catherine T. MacArthur Foundation, the World Wildlife Fund, and others have funded research on native species carried out by scientists associated with OTS. ROCAP-funded research on fast growing exotic and native species (laurel, jaul, chanco, and botarrama) at CATIE under the LEÑA and MADELEÑA projects has also contributed to FUNDECOR's reforestation technology.

Funding to support OTS research on native species will be exhausted soon. The evaluation team learned that OTS has proposed that it join forces with FUNDECOR to seek funds to support continued research by the OTS/TRIALS II project as the "research arm" of FUNDECOR's efforts to promote reforestation in the ACCVC.

FUNDECOR personnel have developed productive working relationships with DGF personnel working in the Puerto Viejo DGF office and in DGF headquarters.

Because the DGF has not reorganized its districts to reflect the yet to be approved conservation areas, FUNDECOR has not developed the same close relationship with the DGF as it has with the SPN DGF. For similar reasons the SPN and the DGF do not yet closely coordinate their activities. However, all three organizations are working to establish closer relationships and define responsibilities. All are participating in the revision of the

SINAC legislation and appear committed to making it work. For instance, the DGF has recently named a forester to coordinate with FUNDECOR and the SPN and to represent the DGF at ACCVC coordination and planning meetings. The DGF coordinator also assists in facilitating the processing of forest management plans, reforestation plans, and subsidy applications submitted by FUNDECOR.

By mutual, but unwritten, agreement FUNDECOR and the Puerto Viejo DGF office have divided the work in the area so that FUNDECOR works within the ACCVC area and the DGF works in the portions of their region which fall outside of the ACCVC. FUNDECOR does some work outside the ACCVC through CACSA and CACSI. FUNDECOR provides xerox and FAX services for the local DGF office and has provided them with a computer and printer. The DGF had space in the FUNDECOR office to distribute silvicultural guides and to keep track of logging, but the DGF has relinquished this space. FUNDECOR personnel report violations of the forest law to the DGF.

The DGF has not reorganized along regional lines that correspond to those of the proposed conservation areas such as the ACCVC. There are several rural DGF offices whose jurisdictions fall partially within the ACCVC. Because FUNDECOR has concentrated its forestry work in the northern portion of the ACCVC, FUNDECOR has had more limited contact with DGF offices working in other parts of the ACCVC. FUNDECOR also maintains strong relationships with the DGF's central office in San Jose. This is probably best exemplified by the success which FUNDECOR has had in negotiating changes in DGF requirements for reforestation and forest management subsidies and by the DGF's recent appointment of a forester to coordinate with FUNDECOR. Also FUNDECOR and the DGF are discussing the possibility of the DGF reserving a portion of its annual budget for reforestation and forest management subsidies for landowners working with FUNDECOR.

Technological Change

FUNDECOR has introduced new procedures for preparation of forest management plans which has reduced time and cost, and improved the quality of forest management plans.

Working closely with the DGF FUNDECOR has introduced Geographic Information Systems (GIS) technology into the preparation of management plans. FUNDECOR contracts with consulting firms for the preparation of forest management plans, using both professionals and paraprofessionals and GIS technology, and obtains DGF approval of the plans. FUNDECOR has reduced the cost of preparing management plans from 7,000 colones per hectare in 1991 to 4,500 colones in 1994. To accomplish this FUNDECOR worked with the DGF to simplify the process of management plan preparation and approval, introduced the use of GIS technology to eliminate some of the

tedious field work, simplified the contracting process, and introduced the use of paraprofessionals for much of the field work.

The use of native tree species in reforestation is one of the most innovative aspects of the FORESTA project.

FORESTA calls for establishing 1000 hectares of new tree plantations and for nurseries to produce 3,000,000 native and exotic tree seedlings over the life of the project. The team found that FUNDECOR is progressing toward these objectives, despite the technological constraints to reforestation with native species. (See Appendix B: "A Brief Agenda for Native Tree Species Research").

Prior to the OTS research on native species, most tropical forest plantation research was with exotic species on good soil types. The OTS research was conducted on soils with limited or no agricultural potential. In addition to the OTS research, CATIE carried out limited research on native tree species under the LEÑA and MADELEÑA projects which concentrated on fast growing exotic species. Drawing on these sources, FUNDECOR has introduced the following new technologies or practices:

- **Selection of native species.** FUNDECOR, with assistance from OTS scientists, has selected 8 species to be used in reforestation within the humid tropical areas of the ACCVC:

Dipteryx panamensis (Almendro)
Vochysia ferruginea (Botarrama)
Vochysia guatemalensis (Chancho)
Virola koschnyi (Fruta Dorada)
Hieronyma alchorneoides (Pilon)
Stryphnodendron excelsum (Vainillo)
Calophyllum brasiliense (Cedro Maria)
Terminalia amazonia (Roble Coral)

- **Seed tree selection and seed collection.** With assistance from OTS, FUNDECOR selected seed trees in the area and contracted with the owners of the trees to collect seeds. For this right, FUNDECOR pays an annual fee which exceeds the stumpage value of the tree. Progeny trials for some of the seed trees are now underway.
- **Seed germination practices.** FUNDECOR-financed nurseries are able to obtain satisfactory germination of the native tree species being used. Seed for one of these species loses its viability within two weeks.

- **Management of selected native species in nurseries.** So far, FUNDECOR's nurseries have not encountered serious problems in producing seedlings of the selected species. EPA approved pesticides (such as Malathion) are used to control occasional outbreaks. Leaf cutter ants are perhaps the most serious problem confronting participating nursery operators. Unfortunately, the most effective control measure (MIREX bait) is not environmentally acceptable.
- **Planting of native species in degraded pastures and secondary forests.** Practices used to establish native species include bare root planting of pylon "pseudo-estacas" and the use of plants rooted in plastic bags for most species. In degraded pastures the area around the seedling is cleaned regularly until the crowns close. Vines are the most serious problem. When establishing plantations in secondary forests, the forest is completely removed for most species, but FUNDECOR foresters are testing planting pylon in varying densities of shade as an enrichment planting.
- **Silvicultural practices for native species plantations.** Plantations planted at 4 meters by 4 meters are thinned after 6 to 8 years. Logs removed in such thinnings can be sold to a pallet mill near Puerto Viejo. For 3 meter by 3 meter plantings, pre-commercial thinnings are necessary three to four years after establishment. FUNDECOR recommends pruning for most species at about the same time as the first thinning. Botarrama, as its common name implies, is a self-pruning species.

FUNDECOR's decision not to develop agro-forestry activities has limited its options for assisting landowners to adopt more sustainable land use practices.

The project paper and the cooperative agreement call for FUNDECOR to introduce agro-forestry technologies in the ACCVC area. A Forestry Support Program team which assessed agroforestry opportunities in 1992 also recommended that FUNDECOR implement the agroforestry component of the project (Diamond, et.al., 1992). The CDIE team found that FUNDECOR is only marginally involved, through CACSA, in the introduction of agro-forestry systems in the ACCVC.

CATIE has developed agro-forestry and silvo-pastoral systems which may be appropriate for many farms within the ACCVC. Government subsidies similar to those legally available, but not

necessarily funded, for reforestation are, according to FUNDECOR staff, also available for agro-forestry.

Despite numerous recommendations FUNDECOR has decided not to implement the agro-forestry component of FORESTA. Apparently the decision to focus project activities on the relatively large land areas which are involved in the project's reforestation and forest management activities to the virtual exclusion of agro-forestry was based on the following factors:

- USAID's desire to achieve quick results in terms of the land area included in improved land use and management activities;
- FUNDECOR's desire to achieve self sufficiency through the marketing of its services and reliance on the CAF to cover the costs of tree planting;
- The belief, reinforced by FORESTA project designers, that agro-forestry involves staff intensive work in organizing farmers' groups which are unlikely to achieve early progress;
- The small size of FUNDECOR's staff.

FORESTA has created a demand for and supply of forestry knowledge that is helping Costa Rican institutions identify critical research issues in forest management.

The FORESTA project draws on research conducted by OTS, CATIE, ITCR, TSC, and others and continues to rely upon these institutions for further development of reforestation and forest management technologies. Little, if any, of this research has been demand driven. In most cases individual researchers or institutions receive grants to carry out research on topics selected by the researchers. Until recently, even the CATIE research on fast growing species (including a few native species) and natural forest management was driven more by the demands of donors than by the needs of foresters implementing field activities. Nevertheless, FUNDECOR owes its success in establishing native species plantations and managing natural forests to such research.

At the same time the need for additional research has become apparent as FUNDECOR attempts to put research results into practice. Even though the FORESTA project benefits from earlier research, its design does not include a research capability to fill the gaps of existing technology or to respond to emerging research needs. FUNDECOR staff are gathering information on the response of native species to planting at varying densities and under varying degrees of shade, but these "experiences" are not designed experiments.

FUNDECOR staff have identified pressing research needs and have submitted a proposal to the FUNDECOR Director to fund research to be carried out jointly by FUNDECOR staff and representatives of research and educational institutions. While the proposal describes the research needs as short term, some of the proposed research, such as the establishment of permanent growth plots in natural forests, is not short term, even for foresters. While communications between technology users and technology developers is improving, there is no mechanism to insure that financing is available to support research which responds to the needs of the users.

Awareness and Education

FUNDECOR education and training efforts have improved forest management knowledge among participating ACCVC resource users and owners -- loggers, land owners.

The project calls for FUNDECOR to prepare and implement an environmental education program. The team found that FUNDECOR has not developed an environmental education program aimed at reaching the general public living in or near, or visiting, the ACCVC but has concentrated its educational activities on individual project beneficiaries - nursery operators and workers, reforestation firms, landowners participating in reforestation or natural forest management activities, etc.

Soon after it began operations, FUNDECOR met with local communities to introduce them to its objectives. Since those early days FUNDECOR has concentrated its informal education efforts on relationships between its staff and individual landowners and workers participating in project reforestation and forest management activities. It has also provided or arranged for formal training for nursery operators and workers, reforestation workers, and loggers.

FUNDECOR has used training to improve performance of program participants and to select participants which are the most suitable to support. Specific training activities have focused largely on technology transfer and include:

- nursery operation and seedling propagation
- tree felling and extraction
- plantation establishment, care and management

One of FORESTA's most effective education and awareness techniques has been the use of contracts which specify how tree planting and harvesting are to be conducted.

FUNDECOR logging contracts contain specifications describing logging practices to be used by contractors to minimize damage to the forest, soil, and water and promote forest growth following the harvest. In addition, FUNDECOR provides training in directional felling to minimize damage to the remainder of the forest as well as the tree being felled. Seed trees are marked with paint and are identified on maps so that chain saw operators can avoid them when felling nearby trees. FUNDECOR also provides training and supervision in road construction, log extraction, and other practices associated with harvesting.

While the evaluation team did not visit an active logging operation to see the recommended logging practices in operation it did examine several recently logged areas, including areas where logs were still being loaded on logging trucks for transport to mills. In all cases but one, harvesting operations did only minimal damage to the forest. The team did see one case where improper felling practices did severe damage to the remaining forest. In this case FUNDECOR foresters called the damage to the attention of the logging contractor and advised that they would have to close down the operation if the contractor did not take immediate corrective action. The contractor immediately hired a FUNDECOR-trained chain saw operator, felling practices improved. In addition to careful directional felling the team also saw several cases where logs were winched from the forest to prevent the damage which would have been done if skidding tractors had moved through the forest to the felled tree.

It was more difficult for the team to assess whether contractors were using improved practices for skidding, loading, and trucking logs. Certainly the knee deep mud on skid trails and logging roads suggested that logging may have been damaging soils and streams. However, there was little evidence of sedimentation in streams where logging roads and skid trails crossed them, and it is difficult to assess whether the disturbance of the soils will have any significant impact on the physical or chemical properties of the soils or on the reestablishment of vegetative cover. It is not possible to carry out an economic logging operation in the humid tropics without disturbing the soil. Soil disturbance could actually be beneficial to the recuperation of the forest and might not have significant impact on streams.

Policy Reform

FUNDECOR dialogue with the Costa Rican forestry service has led to policy reforms that improve the efficiency of the preparation of natural forest management plans and reforestation plans as well as the performance of tree plantations and managed natural forests.

The pace and impact of reforestation and forest management efforts in Costa Rica have been hindered by the complexity of the plan approval processes and by the guidelines established by the DGF. To secure approval and funding for reforestation land-owners must submit a reforestation plan for approval by the DGF. These plans must establish land ownership and describe the type of land, current land use, silvicultural practices to be employed (such as spacing, thinning, cleaning, and protection), and eventual harvesting plans. For many land-owners the difficulties with contracting for, and the costs of, reforestation plans discouraged reforestation. Additionally DGF guidelines were based on exotic species plantations since there has been little experience with native species.

FUNDECOR has worked with the DGF to change the planting guidelines to fit systems using native tree species. FUNDECOR convinced forestry officials that its traditional planting guidance of three meters by three meters was too dense for many of the native tree species which required costly non-merchantable early thinnings when planted too densely. The DGF now routinely approves reforestation plans with three-by-four and four-by-four spacing densities. The reduction in the number of trees -- from about 1,100 to 800 per hectare not only results in better growing stands but also lower planting costs for land-owners and lower subsidy payments for the government.

Requirements for forest management plans were even more complex. Plans submitted to the DGF were voluminous and repetitive and were harvesting plans rather than management plans. FUNDECOR has worked with the DGF to develop planning guidelines which call for pre- and post-harvest silvicultural treatments and reduce the volume and repetitiveness of management plans. FUNDECOR has also reduced the cost of development of forest management plans from about 7,000 to about 4,500 colones per hectare and improved the quality of plans through its use of GIS technology to reduce field work and through careful selection of professional and paraprofessional foresters to do the job.

Additional reforms are emerging in the ways that the Costa Rican government supports and promotes natural forest management. Since 1992, the DGF has been authorized to make incentive payments to land-owners willing to manage their primary natural forests in a sustainable fashion. The DGF recently gave its verbal consent to a FUNDECOR proposal to extend this incentive to secondary forests, thus adding an important natural resource management tool to the alternatives available for use in the ACCVC.

While approved in principle, the Costa Rican government has yet to release any payments for primary or secondary forest management incentives. When funding does flow FUNDECOR expects to use these forest management incentive payments to reimburse its costs.

4. EVALUATION FINDINGS: PROGRAM IMPACT

Impact on Practices

Participating ACCVC land-owners and loggers are now using practices that both reduce damage from selective harvesting in natural forests and raise the profits from logging operations.

FUNDECOR promotes forest management through two creative types of agreements with private landowners. Under the most commonly used arrangement, FUNDECOR provides financial and technical assistance in return for the owner's agreement to follow the management plan and maintain forest cover.

The FORESTA project called for the use of the selection method and the strip shelterwood method, but, because it is not appropriate to the ACCVC's land ownership pattern and terrain, FUNDECOR is not using the strip shelterwood method. The strip shelterwood method, under which narrow strips of forest are clear-cut and all woody biomass is removed, is most useful in forest stands large enough to support annual harvests over the rotation length. Also, rotation lengths under this method are likely to be somewhat longer than under the selection method since this method does not leave smaller diameter trees to grow to harvestable size. Finally, the strip method is not well adapted to rough terrain. However, where it can be used, the strip method can minimize damage to the residual stand and to soil and water resources.

Management plans call for selective harvesting which opens small gaps in the forest, mimicking natural processes. The selection method involves cutting a few mature trees and allowing the remaining trees to mature and natural regeneration to develop in the gaps.

Forests within ten meters of stream banks and forests on steep slopes are not disturbed. The team visited a forest where the management plan called for 80% of the area to be untouched as protective forest to protect streams and steep slopes. The plans contain maps which identify both the trees to be harvested and seed trees to be protected from logging damage. These maps contribute to careful planning of logging roads to minimize the damage to the forest, soil, and streams.

Once the management plan is approved, FUNDECOR contracts the harvesting operation to the highest bidder willing to agree to FUNDECOR's requirements for logging practices which protect

forests, soils, and streams. To date, the increased stumpage prices offered by bidders have covered FUNDECOR's costs for preparing and processing the management plans. Thus, FUNDECOR is able to promote improved logging practices at no cost to the landowner.

FUNDECOR arranges for, or provides, training at which loggers learn to fell trees at an angle to the slope which minimizes damage to the felled tree and avoids damage to selected seed trees and other potentially valuable trees. While logging contractors are not required to use FUNDECOR-trained chain saw operators, FUNDECOR has successfully forced contractors to replace workers who did not meet FUNDECOR's standards. FUNDECOR maintains lists of recommended logging contractors, chain saw operators, and others.

FUNDECOR has established standards for all phases of the logging operation, but, according to Tschinkel, et. al., logging contracts do not adequately define these standards or specify penalties to be invoked when the standards are not met. Logging roads are to follow the route of old roads if the area has been logged before. Tractor operators minimize damage to the soil by keeping their tractor blades up during the construction of logging roads. Tractor operators use cables to pull logs to the tractor rather than driving the tractor to the logs. When the logging operation is completed, logging roads are blocked and drainage is constructed to minimize erosion.

Some cattle ranchers are opting to establish native species plantations on portions of their degraded pastures as long term subsidized investments.

FUNDECOR has had good success in convincing cattle ranchers in the northern section of the ACCVC to establish plantations of native species in degraded pastures. FUNDECOR, and its cooperators, already have agreements with over 80 landowners to establish over 1000 hectares of plantations. Thus it appears likely that FUNDECOR will exceed its life of project objective of 1000 ha. of reforestation but will not approach the very ambitious objective specified in the project's logical framework - reforestation of at least 50% of the Class VIII and IX land in the ACCVC not covered by natural forest. Reforestation contracts vary from 0.5 ha. to 80 ha., with 17 contracts exceeding 10 ha. for almost 46% of the area under contract. Landowners are responding to the combination of government subsidy payments (CAF), low carrying capacity of pastures on the poorly drained soils in the zone, and the presence of a capable organization promoting reforestation (FUNDECOR). Other important factors are absentee ownership, rising labor costs due to the nearby expansion of banana production, and, in at least one case, the desire of a government retiree to leave an inflation-hedged inheritance for his children.

While most landowners have accepted FUNDECOR's native species recommendations, many are hedging their bets by planting old favorites as well as the recommended native species. Because of the demand for native and exotic species which are not on FUNDECOR's recommended list, the FUNDECOR-assisted nurseries produce seedlings of a few exotic species as well as native tree species not recommended by OTS research at La Selva:

laurel (Cordia alliodora) - a common second growth species', especially in old pastures, often used as shade for cacao or coffee in Costa Rica and elsewhere in Latin America. Although a common second growth species in the area, FUNDECOR does not recommend it for planting in the area because of the poorly drained soils which predominate - especially in degraded pastures where the soils have become compacted.

teak (Tectona grandis) - a commonly planted exotic in Costa Rica, especially in the drier areas of the Pacific coast where there are large industrial plantations. Teak is not recommended for the ACCVC area because of the high rainfall - teak grows best in climates with a marked dry season of several months.

gmelina (Gmelina arborea) - another commonly planted exotic but despite its fast growth, FUNDECOR staff believe that the recommended native species will be more profitable in the project area. Like teak, gmelina grows best in areas with a distinct dry season.

The team visited all four of the project's nurseries and four plantations of varying ages. All four nurseries were concentrating on the production of native species recommended by FUNDECOR, but all were also producing laurel, teak, and gmelina in response to demand. All four nurseries seemed to be using the same production practices, and the practices appeared to be adequate. The team saw an insect attack at one of the nurseries and noted that the operator had apparently not acted rapidly to control the attack. The team also noted that physical control (sweeping with a net) would probably have been preferable to the recommended chemical control in this case. One of the nursery operators also noted that FUNDECOR's recommended treatment for leaf cutter ants was not as effective as the use of baits treated with Mirex.

Some landowners, both resident and absentee, are opting to manage natural forests with assistance from FUNDECOR.

Fragmentation of the forest into relatively, for the sake of forest management, small farms has frustrated past attempts to manage the 77,000 ha. of productive natural forest outside the protected areas in the ACCVC. As of December, 1993, FUNDECOR had

entered into agreements to provide financial and technical assistance to assist the owners of 61 tracts (ranging from 5 to 900 ha.) in managing almost 7000 ha. of natural forest. FUNDECOR has also entered into an agreement to directly manage a 1800 ha. tract for its owners. In just 3 years FUNDECOR has been able to enter into agreements to assist in the management of over 10% of the privately owned productive forest in the ACCVC. Most of the owners do not live on their land and only a few have caretakers living on the land. Many of these owners, 53%, do live in, or near, the northern ACCVC.

Table 3 indicates the status of implementation of forest management agreements as of October, 1993. It is important to note that FUNDECOR had completed management/harvesting plans for less than 1/3 of the land under contract at that time. This figure had probably fallen to less than 1/5 by the end of 1993 as additional landowners agreed to participate in FUNDECOR's natural forest management activity at a rate far exceeding FUNDECOR's capacity to contract for the preparation and implementation of management plans. Also many of these contracts call for FUNDECOR to assist landowners in obtaining title and/or developing an ecotourism activity rather than in developing a management plan for the harvest of timber. As of July, 1994, FUNDECOR had signed contracts with landowners which called for various activities which would maintain natural forest cover on over 9,000 hectares.

Table 3: Status of FUNDECOR-Supported Forest Management Agreements

(Figures indicate area in hectares)

| Year | Number of farms | Agreements Signed but without Plans | Agreements Signed + Management Plans Prepared | Agreements Signed + Management Plans Prepared and being Implemented | Total |
|-------|-----------------|-------------------------------------|---|---|-------|
| 1991 | 4 | 87 | 25 | 135 | 247 |
| 1992 | 7 | 100 | 310 | 82 | 492 |
| 1993 | 37 | 3507 | 880 | 82 | 4469 |
| | | | | | |
| TOTAL | 48 | 3694 | 1215 | 299 | 5208 |

As in the case of plantation establishment, landowners are responding to the combination of promised, but not budgeted in 1994, government subsidy payments (CAFMA), and the presence of a capable organization willing to manage the process of management plan preparation and approval and contracting and supervision of loggers. Other important factors include the lack of alternative

uses for the land, enhanced stumpage prices which FUNDECOR is able to obtain, absentee ownership, and the work which FUNDECOR does to establish land tenure.

Natural forest management is a much less costly land use alternative, for both the government and the landowner, than reforestation following clearing (Tschinkel, et. al, 1994). Looking only at the cost of the reforestation subsidy, without considering the costs associated with natural resource degradation, it is in the GOCR's interest to promote forest management and avoid the need for a subsidy to reestablish forest on degraded land. Yet, as Tschinkel, et. al. point out, the Costa Rican government appears to go out of its way to complicate the preparation and approval of what is in reality a harvest plan rather than a management plan and to minimize the profitability of natural forest management.

FUNDECOR, and others, are working with the DGF and MIRENEM to simplify the process and reduce its cost. In the meantime FUNDECOR's availability to represent absentee landowners in the entire process is encouraging many landowners to, at least, take the first step down the road to forest conservation. It is too early to declare the FUNDECOR effort at forest management a success, but it is a promising beginning. Other promising beginnings have encountered obstacles of insecure or inappropriate land and tree tenure systems, market failures, ill advised policies, etc. which they have not been able to overcome. Will FUNDECOR be able to overcome such obstacles when they encounter them? Will the Costa Rican government be able and willing to make the necessary changes in land tenure and forest policy?

Biophysical Impact

Plantations established by FUNDECOR show initial positive signs of healthy tree growth.

According to FUNDECOR data, thirty percent of the area of the ACCVC (85,033 ha.) is in natural forest and 26% of the area (76,600 ha.) has the potential for commercial timber production (Tschinkel, et al, 1994). Commercial natural forest management has the potential to make a major contribution to the conservation of forests and associated natural resources within the ACCVC.

The team visited several recently established plantations in the ten to 60 hectare range. While some of these plantations were in need of weeding, all appeared to be well established with good initial survival. In a few areas where drainage was poor some replanting may be necessary to achieve the desired density. In a few cases crown closure had occurred and weeding was no longer necessary.

Perhaps because the plantations which the team visited were easily accessible, supervision of plantation establishment and maintenance by FUNDECOR personnel appeared to be excellent. Even, in those cases where weeding was overdue, the landowners were aware of the problem and expected to carry out weeding soon. Also, both ITCR and CATIE are carrying out research in some of these plantations. This means that landowners, or their caretakers, benefit from advice from professional foresters from these research and educational institutions as well as from FUNDECOR.

The team met one landowner who had become confused by conflicting advice received from different sources. According to the landowner some foresters had advised him to cut all plants growing near his well established young trees while others encouraged him to leave some of the taller faster growing weeds to encourage rapid height growth, while limiting expansion of the crowns, of his planted trees. This topic may merit further research. More importantly, this landowner had benefitted from reinforcing advice from the different professionals visiting his farm. He was very conscious of the importance of preventing vines from growing on his young trees and stunting their growth and bending their crowns.

FUNDECOR's emphasis on natural forest management and reforestation with native tree species in the buffer zones around the ACCVC's protected areas will, if successful, reverse the rate of habitat destruction and contribute to conservation of Costa Rica's biological diversity.

Damage to forests, soil, and streams is lower where FUNDECOR loggers have adopted selective timber harvesting practices promoted by FUNDECOR.

The evaluation team and others (Tschinkel et. al. 1994) found FUNDECOR natural forest management plans to be well prepared and implemented, and carefully monitored. The plans are oriented toward sustainability and involve landowners in the management of their forests. However, both the team and an individual contacted by the team question FUNDECOR's ability to continue to monitor logging operations as the volume of work increases in the months and years to come.

The evaluation team visited remote forested mountain areas where land owners were harvesting trees with FUNDECOR assistance. The team made visual inspections of the degree of damage caused by selective extraction of trees.

Notable was the reduced size of the open canopy and the lower number of adjacent trees that were damaged in areas where FUNDECOR trained loggers were operating. Tschinkel, et. al. point out that the size of the opening in the canopy may be critical since

openings which exceed 300 square meters may create problems for forest regeneration but also note that research on the relation between size of canopy opening and regeneration success is needed. Roads built according to FUNDECOR specifications also showed less signs of actual and potential erosion and already some progress in regeneration. Particularly noteworthy was the reduced impact of tractors removing logs.

FUNDECOR staff carefully supervise the work of logging contractors to insure that high standards of road construction, felling, and removal of logs are met. The team did meet with one observer who was skeptical of FUNDECOR's ability to adequately supervise the volume of logging going on in the ACCVC under FUNDECOR contracts. This observer commented that Costa Rica has an international reputation for its efforts to conserve its forests and associated natural resources and suggested that extra care is needed to protect this reputation by insuring that loggers adhere to very high standards. The observer was not critical of FUNDECOR's intentions but suggested that FUNDECOR staff is stretched too thin to carry out the necessary supervision. He mentioned that he had recently taken a group to observe a managed forest in a FUNDECOR supervised operation and was surprised to find felling going on during the rainy season. He suggested that FUNDECOR needed more staff to adequately supervise logging operations or should work out collaborative relationships with other organizations to assist in the supervision effort.

The team did not see any felling during the rainy season but did visit several areas where logs were being removed from the forest and walked on woods roads where the mud, churned up by tractors and trucks, was almost knee deep. The team observed streams which were muddied at the road crossings but flowed clear only a few meters downstream. There was some siltation at, and just below, the stream crossings. In one recently logged area the team observed abundant natural regeneration in the muddy logging road. There is no doubt that logging in wet tropical forests disturbs the soil and other natural resources in the short term, but it is the long and medium term which are of concern. Unfortunately, other than one area where CATIE researchers have installed plots to monitor some of the impacts of harvesting operations, FORESTA does not have a monitoring program in place to assess the impact of logging on the forest.

Tschinkel, et. al. point out that the standard 60% cut of harvestable timber called for in FUNDECOR's management plans does not adequately provide for the regeneration of scarce tree species. Similarly, adherence to a minimum diameter of 60 cm. forces loggers to cut some species which often are hollow by the time they reach this size (such as botarrama) while not allowing them to cut smaller, but merchantable, diameters of these species.

Socio-Economic Impact

By acting as an intermediary buyer of seed and seedlings and as a contractor for tree planting and management services FORESTA, through FUNDECOR has generated direct investment and employment in seed collection, nursery seedling production, and reforestation and has increased landowner's incomes from timber planting and harvesting.

The current single seed collection contract, four nursery contracts and range of tree planting contracts represent the start of a new native tree species based industry. The nursery operators also represent a spectrum of social and economic backgrounds of potential investors and workers in the business.

Seed collection contracts save trees as well as generate income. The team learned of one land owner who was about to sell a tree from which the project had been collecting seed to a logging contractor for about 20,000 colones. The land-owner agreed to spare the tree when he learned that it produced about 40,000 colones worth of seed annually for which FUNDECOR was willing to contract. Other land-owners in the area have also begun to appreciate the economic value of native trees as seed producers. FUNDECOR has now identified a small population of seed trees for use in its planting work and made arrangements with tree owners for long-run seed collection contracts.

Tree nurseries are labor-intensive operations that generate jobs. One FUNDECOR-assisted private nursery employs up to 12 laborers in seedling production. Both women and men participate. The nursery owner indicated that several workers had been employed by the nursery long enough to develop on the job skills sufficient to carry on many of the nursery operations in his absence. He has plans to use some employees to help set up and manage satellite nurseries in other locations to meet the expanding demand for native tree seedlings that he anticipates.

FUNDECOR tree planting contracts also provide employment and incomes. Both men and women engage in the reforestation program. Men are engaged in the heavier clearing of trees and brush around the areas to be planted. Because women are more careful in the transplanting of trees they are preferred for this task.

Tree seedlings sell for between 15 and 20 colones in bags and 12 to 15 colones in cuttings. About 1/3 of the average selling price is profit, the balance covers cost of seed and bags (3 colones) labor (10 colones) and other expenses (2 colones). Because a market is only now emerging for native tree species seedlings, there is little price difference among varieties even though costs of production vary widely due to different demands for germination and cultivation.

41

In its efforts to maintain existing forest cover by maximizing the benefits to owners of forest land, FUNDECOR also contracts with landowners to assist them in obtaining clear title thus making it unnecessary for them to clear the forest to obtain title. Through these arrangements FUNDECOR is able to obtain higher financial returns for landowners, while minimizing the damage to the forest, by (1) preparing management plans and obtaining DGF approval of the plans, (2) auctioning logging rights, and (3) insuring that loggers follow the management plan and prescribed logging practices (Tschinkel, et. al. 1994). FUNDECOR has also reduced the costs of tree plantation establishment by combining the land of several landowners and letting large contracts for land clearing, seedling planting and tree management -- weeding, fertilization, pest control as needed.

5. EVALUATION FINDINGS: PROGRAM PERFORMANCE

Program Efficiency

FUNDECOR has increased the efficiency of reforestation and natural forest management resulting in reduced plantation costs, reduced management plan costs, and higher timber prices for land owners.

FUNDECOR has reduced the costs of plantation establishment by combining the land of several landowners and letting large contracts for planting and cleaning. Similarly, FUNDECOR recently initiated the practice of combining the timber holdings of several landowners and auctioning the timber harvest rights on the combined holdings. The combination of larger harvesting contracts and sealed bid auctions has resulted in significantly higher stumpage prices to the owners, an increase of 11 to 15 colons per Costa Rican inch (a measure approximately equal to 11/12 of a board foot). The reduced cost of management plan preparation discussed in Chapter 4 also adds to the improving income stream from forest management.

FUNDECOR recovers its costs for preparing plans and supervising planting and harvesting contracts by signing agreements with landowners, who agree to deduct these expenses from the tree planting and management subsidies paid by the GOCR. So far, FUNDECOR has been able to hold reforestation costs within the reforestation subsidy (up to 132,000 colons per hectare over five years in government bonds for landowners with clear title but only 58,000 colons over three years for owners without clear title), but rising labor costs make it doubtful that this can be continued. Of course, when the landowner and/or his family provide some or all of the labor, the landowner is able to directly benefit from the subsidy.

The forest management subsidy (80,225 colons per hectare) does not cover all of FUNDECOR's costs. FUNDECOR recovers the balance of its expenses at the time of timber sales. Because of increased stumpage prices and lowered management plan costs the landowner realizes greater income, even after FUNDECOR's costs are deducted.

Assisted natural regeneration to establish secondary forests in degraded pastures might be more efficient for the project and the Costa Rican government than plantations of native tree species.

One of the difficulties in managing pastures in lowland areas of Costa Rica is controlling the invasion of tree species. A few years ago, in the 1970s, CATIE foresters found a landowner in the Siquirres area who had decided to convert the invasion of secondary tree species to his advantage by allowing selected species to invade his pastures. By the time the CATIE foresters found him he had already converted several hectares of pasture to a managed secondary forest, rich in marketable species. With assistance from CATIE he was able to improve his management practices and decided to convert all of his pasture to secondary forest. The landowner made this conversion to forest at no additional cost. His forest was more species rich than a native species plantation and probably provided a more diverse wildlife habitat than plantations. At that time reforestation and forest management subsidies were not available, yet the landowner believed it was in his economic best interest to convert his pasture to forest (Rosero, personal communication).

The major constraint to such secondary forest management is that the landowner must have another income source or sufficient land so that the conversion to forest can go on over a time period which allows the landowner to replace his ranching income with income from forestry. Since silvo-pastoral systems can be adapted to the conversion process, a landowner can continue ranching throughout the conversion process, or, in appropriate sites, continue to raise cattle with trees in his pastures. In any event, this constraint to secondary forest management is even more applicable to the establishment of plantations.

CATIE's research results from Siquirres, Turrialba, and San Isidro del General could be applied within the ACCVC (Budowski, n.d.). For many farmers the opportunity to convert pasture to forest through the management of the natural regeneration in their pastures may be preferable to the establishment of plantations. The availability of a subsidy for tree planting and the absence of such a subsidy for establishing a forest through natural regeneration may encourage farmers to establish plantations rather than a more ecologically sound secondary forest. Certainly this appears to have been the case for FUNDECOR.

Nevertheless, the establishment of secondary forests through natural regeneration may be a much more efficient process for the landowner, the GOCR, and the public at large than subsidized reforestation programs. Through group training and extension programs for landowners and/or their caretakers or foremen, large areas could be reforested over a short period of time at very low cost.

Program Effectiveness

FORESTA reforestation and natural forest management programs include a broad spectrum of socio-economic groups, but by emphasizing larger landowners an opportunity to address inequitable access to economic opportunity as one of the major causes of natural resource deterioration is missed.

By its nature and design FORESTA has two features that bias its focus on more well-to-do direct beneficiaries, or at least on owners of larger landholdings. Both the GOCR reforestation and the forest management subsidy programs have title requirements and minimum area requirements that restrict their availability to small landholders. A separate reforestation subsidy program has been designed for small farmers, and FUNDECOR has assisted both CACSA and CACSI to access this program for their members. Even the benefits of this program can be captured by larger landholders - the team met two CACSI members who are professionals who reside and work in San Jose but are reforesting medium sized landholdings in Siquirres canton through the small farmer subsidy program by reforesting the maximum area (five hectares) allowed under the program every year for several years. Finally, the slow rate of cash returns might be expected to discourage participation by smaller land-owners.

In practice, FORESTA has reached both large and small land-owners, as well as a range of rural workers and households through its contracting arrangements for reforestation and forest management. The team visited one owner of 72 hectares who had arranged with FUNDECOR to reforest 26 hectares of his flat pasture land with native tree species. This land owner, a retired government official, appeared to view reforestation as a worthwhile investment risk for himself and for increasing the value of his land as an inheritance for his children. Nearby, in a very mountainous region, FUNDECOR is assisting other land-owners of modest means in the selective extraction of trees from natural forests as part of sustainable yield management plans. One of these landowners, one of the first to sign a forest management agreement with FUNDECOR, works as a laborer/contractor for FUNDECOR cleaning the weeds from a large native species plantation owned by a San Jose resident. While these land-owners are not among the lower income strata, they are, by no means, large farmers or cattlemen on the upper end of the income scale.

Day laborers and seasonal laborers have derived direct project benefits working in the tree nurseries and plantation establishment and maintenance activities. Tree seedling production engaged both men and women in almost equal numbers at the nurseries. In one of the two family run nurseries both the husband and wife, as well as the older adult female children, were actively involved in daily

operations. Project records show that men perform the harder tasks of tree planting in cleared and semi-cleared areas.

Program Sustainability

The economic viability of the ACCVC reforestation program is dependent on some critical assumptions about the performance of native tree species and the continuation of public incentives.

Available data from OTS research on native tree species in plantations point to a promising but inconclusive outcome for commercial plantations of native species in the ACCVC. The conditions under which these plantations are managed differ significantly from the old-growth forests in which they evolved.

Moreover, there is still insufficient data available for FUNDECOR and the DGF to use in determining how adaptable many of these native species are to different growing conditions -- soil types, drainage, and rainfall patterns or how susceptible they might be to disease or insect attacks.

The impact which repeated harvesting of plantations might have on soil fertility and structure is not known. On some infertile tropical soils, repeated harvesting of pine plantations has resulted in decreased fertility and slower tree growth. Because plantations are normally clear cut, the impact of harvesting can be very different than selective harvesting of natural primary and secondary forests. Since there are no trees available to store nutrients released from decaying organic material, nutrients may be lost from the system. Since soils are exposed to sun, rain, and wind, they may bake, crack, and become less permeable. Runoff may increase, and local flooding may result. However, while forest plantations may not be sustainable for the long term, they are more likely to be sustainable than the pastures they are replacing. Uneven aged management of secondary forests, through selective cutting, is more likely to be sustainable than forest plantations.

FUNDECOR's promotion of native species plantations must be considered experimental at this time. The OTS research upon which this activity is based was carried out under very limited conditions, which do not reflect the site variability encountered in the fields where plantations are being established. Similarly, not even the small plantings at OTS are old enough to establish rotation lengths or provide the information necessary to calculate rates of return on investments in forest plantations.²

Similarly, while the logic of using native species plantations to enhance wildlife habitat in buffer zones appears sound, there is not yet sufficient evidence to support this hypothesis. The

plantations are still too young and do not cover a large enough area to have a significant impact on wildlife habitat.

The evaluation team has seen some promising initial reforestation progress in the ACCVC. Participating land-owner enthusiasm is high and motivation of FUNDECOR staff is strong. DGF support is encouraging, with the approval of subsidies for reforestation plans which differ from customary practice and the consideration now being given to the possibility of reserving subsidy funds to support FUNDECOR programs.

At the same time, there is a widespread recognition that the performance of native tree species is yet to be determined. The risk to the landowner is greatly reduced by the subsidy and the shortage of alternative sustainable land uses.

Another long-run uncertainty is how long the Costa Rican government will be willing and financially able to subsidize reforestation costs. The 120,000 colones per hectare subsidy now provided is arguably important to help many land-owners finance investments in clearing, planting and managing the land on which new trees are planted. Demand for reforestation subsidies on a nationwide basis already exceeds the funds available. Without outside financing, perhaps in the form of payments for carbon sequestration, the GOCR probably cannot expand the reforestation subsidy program to support the reforestation rates needed to have any real impact. With labor costs increasing some landowners may lose interest in the program unless the size of the subsidy is increased. Maintaining the current subsidy might help adjust supply and demand and result in landowners assuming more of the risk involved.

One hopeful sign on the fiscal horizon is FUNDECOR's finding that native tree species should be planted at much lower densities -- 800 instead of 1,100 per hectare -- which significantly reduces the planting and early management costs. In turn, lower per hectare subsidies are needed, allowing the government's incentive program to cover a larger area.

FORESTA has not examined the market potential or developed a marketing strategy for the tree species it is promoting in its reforestation program.

FUNDECOR is encouraging farmers to invest in the planting and management of native tree species without having done much in the way of studying future markets or developing market strategies for timber products. Apparently, FORESTA project designers were sufficiently convinced that future timber shortages would be so great in Costa Rica that it would be easy to place trees in the domestic market when they were ready for harvest.

There may indeed be a strong future demand for forest products. It would also appear true that the volume of timber produced under the most optimistic projections of FORESTA success would be too small to affect that market significantly. Nevertheless, without a more systematic and thorough analysis of domestic and international markets, FUNDECOR will have a difficult time attracting outside investment and financial support to keep its program growing. Any commercial enterprise would have an early eye on market performance and growth and have at least a tentative marketing and sales strategy for the output of its clients. FUNDECOR is taking some risks -- and asking program participants to do the same -- by not commissioning a more serious study of timber products markets. However, as discussed above, the GOCCR, through its subsidy program, is the major risk taker in the reforestation program.

The long-run financial soundness of FUNDECOR is still subject to conjecture given that income and cost projections are based on a series of optimistic cash flow assumptions.

While FUNDECOR continues to progress in developing and supervising natural forest management plans and reforestation contracts, the foundation has a long way to go to reach a level of activity that will generate a cash flow from management and contracting services that can cover many of the fixed and operating costs now met by FORESTA funds. The FORESTA TA contractor is now beginning to monitor and analyze task and time allocation among FUNDECOR reforestation and natural forest management activities. The data will help determine the level of FUNDECOR services and amount of land in forest plantations and in natural forest management needed to sustain FUNDECOR as a self-financing operation.

FUNDECOR recovers its costs for preparing plans and supervising planting and harvesting contracts by having landowners agree to turn over their reforestation and forest management subsidies to FUNDECOR. So far, FUNDECOR has been able to hold reforestation costs within the reforestation subsidy, but rising labor costs make it doubtful that this can be continued.

The forest management subsidy (80,225 colons per hectare) does not cover FUNDECOR's costs. However, because of the increased stumpage prices FUNDECOR has been able to obtain by combining sales and preparing and obtaining approval of management plans (a service normally performed by the logger) the landowner profits by contracting with FUNDECOR.

Program Replicability

Reforestation with native tree species has already begun to spread beyond FUNDECOR operations in the ACCVC.

The availability of the reforestation subsidy (CAF) has resulted in a growing interest in establishing plantations throughout Costa Rica. Despite the limited experience with native species plantations in Costa Rica and limited nursery capacity, the early experience of FUNDECOR with native species is already being transferred to other areas. ITCR, OTS, and STON Forestal, with funding from USAID, are carrying out research with native species in the much drier southern zone. Some of the species being tested are the same as the species being used in the ACCVC - but the seed sources are different.

Closer to home, nurseries in ACCVC are selling both native and exotic species to landowners in the San Carlos area of the Northern Zone and in the Atlantic Zone around Limon. Organizations from several zones, including the Northern, Atlantic, and Southern Zones, have joined together to form an association of groups interested in native tree species plantation technology.

Other forces at play are the concerns of land-owners that the failure to put their land to better use than just pasture may result in losing it to squatters who have repeatedly moved onto lands in the ACCVC area and other surrounding areas. As one observer pointed out, all a squatter has to do is put up a fence and a house on pasture land and he becomes a social burden that is hard to remove. In Costa Rica, according to FUNDECOR staff, a squatter who moves onto forested land, however, must clear the trees to do so -- a task that requires more work and an activity that is illegal giving the landowner more justification to take action to remove the squatter.

Tree nurseries propagating native species seedlings have yet to expand in size and numbers to meet growing demand for planting stock.

In its third year the project has gone from 8 nursery contracts to 4 as it weeded out those individuals unwilling to follow FUNDECOR's recommendations for the production of quality seedling stock. With no firmly established seed supply and with FUNDECOR still needing to play a supporting role in obtaining materials such as seeds and plastic bags, the scope for spread of native tree species nurseries is limited to what FUNDECOR can contract.

The volume of native and exotic tree seedling production in Costa Rica has not yet reached a level sufficient to justify the production of black plastic bags on other than a special order basis. Producers of plastic bags have yet to respond to this market segment. The substitution of other devices such as root trainers has not met with great success given the cost and the size of seedling stock required (especially for those species where "pseudo estacas" are used to establish plantations).

The native species information base of eight to ten years on native tree species performance -- as limited as it is -- is unique to the ACCVC and not available for supporting the replication of FUNDECOR reforestation in other areas.

OTS, and others, have recently begun research on native species in the Atlantic and southern zones of Costa Rica. It will probably take at least until the year 2000 before enough data is available to support native species plantation programs in either of these zones. Despite the lack of research, some risk takers are already involved in tree planting programs which include native species in each of these zones. As discussed above, FUNDECOR's native tree species plantation program is not risk free, but attempting to implement a similar program without at least a similar research base will greatly increase the risk.

It will probably be much longer before a native species program similar to the FUNDECOR program can be replicated in many other Latin American countries. Few, if any, Latin American countries have access to research institutions with the facilities, personnel, and financial support available to OTS, CATIE, and their Costa Rican collaborators. A plantation program similar to FUNDECOR's should be implemented elsewhere only if significant research results are already available and local institutions are available to provide research support for the program. Perhaps the new Center for International Forestry Research (CIFOR) will promote research on native species plantations in addition to its emphasis on natural forest management. If so, the major constraint will remain the scarcity of well supported forestry research institutions in developing countries. Without such institutions, any attempt to replicate FUNDECOR's program will be very risky.

Government subsidies can transfer much of the risk to the government. However, governments with the means and the interest in subsidizing the conservation of forests can probably make most efficient use of the funds available by prioritizing their investments as follows:

- Management of natural forests, primary and secondary (prevention of damage through maintenance of existing vegetative cover),
- Promotion of natural regeneration of secondary forests,
- Agroforestry, and
- Reforestation using the exotic or native species most likely to achieve desired objectives.

6. LESSONS LEARNED

Land tenure policy must be clear and unambiguous if it is not to obstruct progress in reforestation and in natural forest management.

Costa Rica has been blessed with an environmentally responsive political leadership that has moved the country far ahead of most developing nations in setting up a protected area system. Unfortunately, in doing so government agencies have trampled individual rights. Lands have been confiscated within newly declared protected area boundaries, but little or no compensation has followed. Poorly conducted cadastral surveys have led to disputes over whether or not other properties were even within park boundaries.

The haste with which some protected areas have been set up has created an atmosphere of distrust and confusion among many land owners in and around the new protected areas. Those located within newly declared regional conservation areas, but not compensated, have chosen to continue to extract trees or continue farming activities feeling that they should get as much from the land as possible since the government has not purchased the land. Owners of lands bordering the parks are discouraged from participation in natural forest management for fear their land may be the next to be included within protected areas. Better to log the land and put cattle on it to get some returns before it is taken by the government. Maybe with the forest removed it will be less attractive.

Such attitudes and behavior and resulting environmental damage can be avoided if the government pursues a more responsible land use program that is transparent and understandable, with local community participation in the process. As it stands now, the government's inability to follow through with its land purchasing program continues to feed suspicions and uncertainty that lead to the very deforestation and habitat degradation its programs are aimed at averting.

Contracting for services can be an effective vehicle for transferring knowledge, raising awareness and changing behavior of natural resource users.

FORESTA has introduced contracting for natural resource management as a means of encouraging private tree planters and loggers to adopt more responsible forest management practices. Forest management contracts contain a range of specifications

regarding tree extraction in a fashion that does the least damage to the forest. FUNDECOR administers the contracts and supervises their compliance.

In natural forest management, contracts have already proven to lead to more responsible tree harvesting behavior. FUNDECOR has threatened to halt contract work and suspend payments, or activate penalty clauses where contractors have failed to comply with resource use and management requirements specified in the contracts. In response loggers have corrected their practices even to the extent of replacing workers with those trained by FUNDECOR.

Monitoring natural forest habitat change and its relationship to reforestation and forest management might better be undertaken entirely apart from the agencies, public and private, responsible for directing and supervising forest operations.

At present, the FORESTA project calls for FUNDECOR to work with the ACCVC-SPN and DGF to develop and implement a monitoring program for its activities in and around parks and buffer zone. To do so places FUNDECOR in the role of a watchdog over itself as well as over the agencies it is supporting. The potential conflict of interest and adversarial relationship that might result from FUNDECOR directing a monitoring program may impact adversely on its ability to carry out that support role.

An alternative scenario might be the formation of an independent monitoring function with separate funding source. Organizations exist in Costa Rica capable of performing monitoring roles and addressing researchable issues that might come up in the course of monitoring. One measure that might be considered is the introduction into the FUNDECOR charter of a provision for periodic renewal of a foundation's status based on an independent monitor's assessment of the beneficial impact that it has made. A foundation, no matter how successful it might be financially, should be accountable periodically for what difference it is making in carrying out its mandate.

USAID must balance the program goals of community service and financial solvency when supporting newly established environmental NGOs.

Most experts now agree that community participation, equity, and broad based environmental education programs are not lofty ideals but rather are essential ingredients of successful natural resource conservation programs. Programs which depend upon subsidies to large landowners or keeping people out of "protected" natural areas have consistently failed. While promising approaches exist, programs which rely upon community participation in the

development of the economic potential of protected areas and their buffer zones have yet to demonstrate that this strategy is more successful. Such programs are a relatively recent phenomenon and are difficult to implement in a way which insures that their economic benefits are not captured by an elite minority, as may be happening in FORESTA.

FORESTA project design contains elements of both approaches with an emphasis on the participatory approach, but most of the participatory design elements have been discarded during implementation. Perhaps the land tenure situation in the ACCVC is not appropriate for a participatory approach to natural resource management, perhaps an "elitist" one-on-one approach is in FUNDECOR's best interest for long-run institutional survival, or perhaps project designers made it too easy for the project implementers to select an approach which benefits the members of their socio-economic group or the group to which they aspire.

FUNDECOR's claim that the approach is necessary for FUNDECOR's financial survival is understandable. With a short life of project, limited funding, and an endowment which remains in doubt, FUNDECOR was faced with a difficult choice - to face extinction when USAID support came to an end, to devote a significant portion of its resources to seeking additional donor support, or to concentrate its energies on designing and implementing activities likely to provide continuing income after FORESTA. Considering the number of donor created institutions which never look into their financial futures, FUNDECOR is to be congratulated for selecting a course which allows it to concentrate its efforts on natural resource conservation activities which will provide income to support a reduced level of activity when the USAID project comes to an end. Nevertheless, it is yet to be demonstrated that this approach will ensure either the survival of FUNDECOR or the conservation of the ACCVC's natural and archeological resources.

USAID must be prepared to provide long term project assistance when attempting to establish and strengthen new NGOs with broad responsibilities for cooperating with government agencies, research and educational institutions, other NGOs, and community groups to conserve forest resources.

USAID support to FUNDECOR through the FORESTA project will last less than five years. This may prove to be insufficient to establish FUNDECOR as a permanent NGO responsible for cooperating with others to carry out the activities necessary to address conservation priorities in the ACCVC.

USAID designed FORESTA as a seven year project, and the agreement signed with the GOCR on 4/28/89 established the project assistance completion date as 3/31/96, not quite a full seven

years. The budget included \$7,500,000 from USAID and a GOCR contribution of 1,200,000,000 colones (including 810,000,000 colones for the endowment). Over two years passed before the Costa Rican legislative assembly approved the project and USAID and FUNDECOR signed a cooperative agreement to start work.

During the three years since the effective date of the cooperative agreement FUNDECOR has made progress and demonstrated imagination in implementing the project, especially the forest management component. However, as should be expected from a young organization with a small staff, FUNDECOR has done less to implement other activities such as agroforestry, environmental education, community participation, research and monitoring, and staff training - activities which many practitioners agree are vital to the long term sustainability of conservation programs.

FUNDECOR has emphasized forestry activities which, because they are eligible for government subsidies, will generate revenues to supplement income from its endowment fund. The natural forest management activity is an appropriate priority activity because it prevents, or minimizes, damage to forests and associated natural resources and obviates the need for expensive restoration measures, such as reforestation. The establishment of plantations, on the other hand, may not be the most appropriate restoration measure - other, generally less costly, alternatives are natural regeneration of secondary forests and agroforestry.

FUNDECOR is to be congratulated for the concern it has shown for financing in the post-FORESTA era. Many USAID supported organizations have shown much less concern for their futures, expecting USAID to come to the rescue. Four, five, and even seven years are not enough time for a new organization to develop and implement a program which addresses the short and long term forest conservation needs of an area as complex as the ACCVC. USAID needs to be prepared to assist organizations like FUNDECOR to develop innovative approaches to forest conservation and to provide continuous support over an extended period.

In projects based on the introduction of new technologies USAID project design should analyze the need for continuing research support and, if appropriate, provide for such support.

FORESTA project design created a new NGO to collaborate with a variety of organizations and groups to introduce natural forest management, native species plantation, and agroforestry technologies in the buffer zones within the ACCVC. Plantations with native tree species, in particular, are based on emerging technologies and incomplete research results. The lack of readily available agroforestry technology packages appropriate for the biophysical

and socio-economic conditions of the ACCVC probably contributed to FUNDECOR's decision not to implement this component of the project.

USAID forest conservation projects should analyze the technologies being introduced to determine the need for, and availability of, continuing research support. FUNDECOR has entered into a variety of arrangements with research institutions to insure that research is carried out on some of the more pressing research needs for its plantation and forest management programs. Neither FUNDECOR nor its collaborating research institutions appear to have the financial resources to design and carry out much of the research which is needed to support the conservation of forests and associated natural resources in the ACCVC.

APPENDIX A

EVALUATION PROCEDURES

CDIE assessments of environmental programs are aimed at answering two central questions: "Has USAID made a difference?" and, if so "How well did it do it?" The central hypothesis of the environmental assessments is that USAID, through the right mix of program strategies, can impact on local conditions and practices to produce favorable long-lasting changes in the bio-physical environment and on the socio-economic welfare of cooperating countries. This Appendix describes the process used to test this hypothesis in USAID social forestry programs.

Impact - How much?

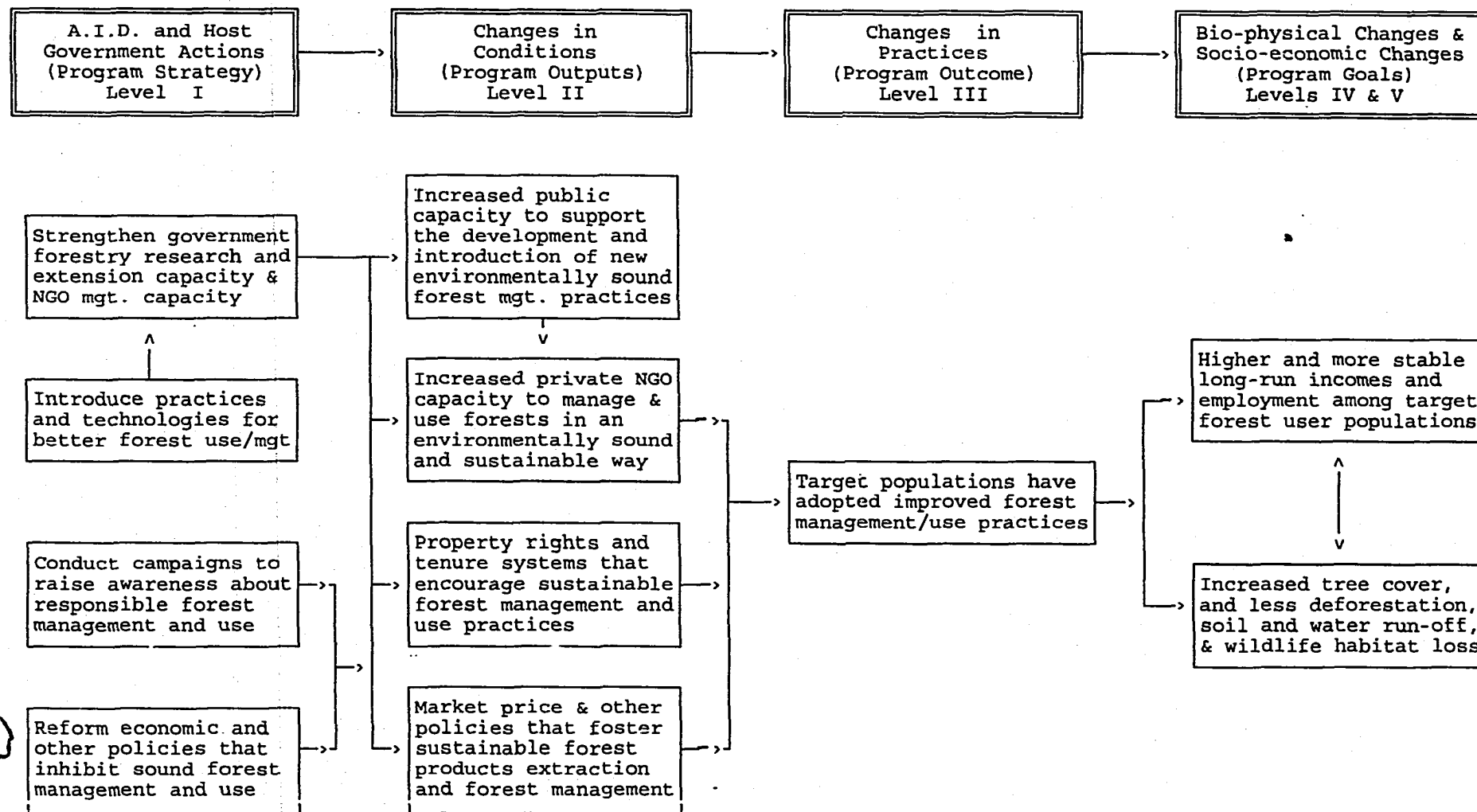
The assessment seeks to establish plausible association between USAID program strategies or activities and changes in environmental quality, natural resource management and socio-economic well-being. In answering the first question, "Did USAID make a difference?", the assessment has attempted to document what happened or can be expected to happen. In Costa Rica the evaluation has gathered and examined "impact" information to determine whether USAID projects accomplished their goals of increasing sustainable local forest management. The evaluation examines the relationships between environmental impact and USAID program strategies using a five-level analytical framework. (Figure A-1.)

In the analytical framework, Level I lists the "program strategies" that USAID and the host government employed in implementing social forestry programs receiving USAID support. These strategies include: building community level research, training and extension institutions, introducing new forest management practices and techniques, fostering awareness and formulating public policies that support local forest management.

At Level II, "program outputs" are the conditions that have resulted from implementing these strategies. They include: staffing and equipping a regional NGO, newly formed local NGOs, new tree species, and management practices identified as sustainable, and changed policies and regulations affecting locally managed forests.

The Level III "program outcomes" resulting from changes in Level II conditions are the adoption of forest management practices by target populations.

Figure A-1: Framework for Assessing the Impact of USAID Forestry Programs



Level IV and V "**program goals**" constitute the biophysical and socio-economic changes resulting from the adoption of Level III program outcomes or practices. Level IV and Level V goals can be viewed and mutually supportive. For the purposes of the evaluation, Level IV "**bio-physical goals**" are the program's environmental objectives, e.g., increased tree cover, and less deforestation, soil and water run-off, and restored wildlife habitat.

Level V "**socio-economic goals**" include sustainable increases in income, employment, and overall well-being of program participants. While access to income data is difficult, the continued involvement of beneficiaries in the program can be used as a "vote with their feet" proxy indicator of positive socio-economic impact.

Performance: How well?

In answering the second question, "How?", CDIE's primary concern is the **efficiency, effectiveness, sustainability** and **replicability** of the program.

Where data exist, the evaluation measures program **efficiency** by using monetary estimates of the flow of benefits to calculate an economic rate of return for those USAID and host government program investments to which benefits can reasonably be attributed. Because benefits occur into the future, their anticipated value must be annualized, adjusted to net out all costs incurred, and expressed as a discounted present value to compare to project investments.

To assess program **effectiveness**, the evaluation examines how well project sponsored technologies and services (e.g., training) are reaching intended target groups and whether there is equity or bias in access by participating target groups. Effectiveness indicators include trends and patterns of delivering services according to the make-up of target groups (e.g., gender or socio-political status).

The examination of **sustainability** is important at all program levels (Figure A-1). For example, will new (Level II) conditions created with USAID assistance continue or will they be reversed? Will target participants continue to employ newly introduced (Level III) practices? Will new (Level IV) forest management systems thrive over the long-run? Will increased (Level V) incomes, profits and jobs continue after USAID and host government support is withdrawn? Evidence of sustainability includes the continuation of activities, regulations, price structures and institutions beyond the termination of USAID technical and financial assistance either on their own "internal" momentum or with host government or with other donor assistance. The principle measure of sustainability is the number of beneficiaries continuing to employ project promoted practices after USAID support has ended and the nature of added government and donor support provided USAID initiated

activities. Indicators of bio-physical sustainability include trends in tree species and soil quality in target areas.

To determine the **replicability** the evaluation examines whether conditions and practices, promoted by the program, have spread beyond the target areas and whether such spread is "spontaneous", occurring among participants by "word of mouth" or other means without further outside support, or "induced" by public, private or donor agencies which have picked up on an USAID supported concepts and introducing them elsewhere. Replicability indicators include number of similar activities supported by local or international agencies outside the program target area and population; number of participants outside the target area that have adopted in sum or in part USAID sponsored practices.

Data collection procedures

CDIE employs a variety of primary and secondary sources of data and information to construct the chain of events linking program activities and resulting observed effects and impacts, to examine major evaluation issues, and to identify lessons learned.

In preparation for the field work CDIE collected and analyzed relevant secondary data and information available in Washington or in host countries from a range of sources including project documents, technical reports, and special studies that are available with the Agency's Development Information System.

In the field, the evaluation team reviewed studies and reports conducted by host government agencies, private voluntary organizations, and international institutions. The team was fortunate to discover a number of comprehensive surveys and reports prepared by other donors as well as USAID. Because acquisition of primary data was also called for, the assessment team also visited a number field sites to make visual confirmation of changes that have occurred since USAID support began and to conduct key informant interviews as part of its primary data collection.

The extent of forest management was determined for each of the field sites which the evaluation team visited and based on three qualitative criteria:

- Share of potential hillside areas in project forests.
- Degree to which forest management practices were followed
- Degree to which forests were generating benefits (e.g. revenues, products).

APPENDIX B

A NATIVE TREE SPECIES RESEARCH AGENDA

The USAID FORESTA project is performing commendable pioneering work in the introduction of native tree species in reforestation and in the sustainable yield management of natural and secondary growth forests. At the same time there are major risks for FORESTA and participating land-owners investing in native tree species plantations or natural forest management given the gaping knowledge gaps that still exist for many native tree species.

FUNDECOR's operations provide very attractive opportunities for applied research and field testing in the context of "on-farm" forestry programs. To its credit, FUNDECOR has attempted to draw other institutions into research agreements rather than attempts, with its limited resources to conduct research itself. In addition to researchable problems that FUNDECOR has tried to promote among the Costa Rican scientific community, the evaluation developed a list of other issues that combined make for a brief agenda for native tree species and natural forest management research.

Native Tree Species Research

The use of native tree species in reforestation is a risky concept given the limited knowledge about the silviculture, autecology, and production economics of the species selected. During a recent visit to the FORESTA project by U.S. Forest Service personnel one of the visitors asked about growth and yield projections for the native species being used. In response he was told that "no [OTS-supplied] information is available on tree growth beyond four years." The questioner commented that "the farmers are taking quite a gamble". Despite the risks, many farmers in the ACCVC, perhaps motivated by the government subsidy, are taking the gamble.

There has been more research with exotic species throughout Central America through two ROCAP projects with CATIE, MADELEÑA, and its predecessor, LEÑA. As a result much more is known about seed tree selection, seed collection, seed storage and treatment, nursery practices, seedling establishment, silvi-cultural practices, and growth and yield for exotic species than for native species.

FORESTA project designers selected native species because of their potential contribution to habitat in the buffer areas within the ACCVC. Lack of baseline data and a monitoring system means

that this hypothesis will not be tested, other than anecdotally. Several technology gaps remain:

Tree species genetics. OTS has assisted FUNDECOR in selecting seed trees from which to collect seed for planting within the ACCVC. Seed tree selection is based on such characteristics as straightness of bole, size of crown, and self pruning, but little is known about the heritability of these characteristics or the interrelationships of genetics and site and other environmental conditions. Limited provenance trials are underway at OTS' La Selva station, but not at other sites within the ACCVC. These trials illustrate the risks involved in extrapolating limited research results to recommended practices - the progeny of one of the seed trees being tested had forked and crooked boles, greatly reducing their potential value as saw logs or veneer logs. In fact, if these trees had been included in a plantation, hopefully mixed with the progeny of other seed sources, they would have been eliminated at the first thinning.

Tree seed collection and handling. The timing of flowering and fruiting of some tree species varies by region within Costa Rica and from year to year. The quantity and quality of seeds produced varies from year to year. For some species good seed crops occur only every 3 or 4 years. Because of the variability of seed crops, there is a need to store seed from good seed years for planting in years in which there is little or no seed production. Research is needed to determine the viability of native species tree seed over time and the effect of storage techniques on viability. One of the species used loses its viability if not planted within about 17 days from the harvest date. Research on seed storage techniques may be able to extend the viability of this seed.

Tree seedling propagation. Applied research is needed to refine a variety of nursery practices such as seed pre-germination treatment; seed bed preparation; shade and light requirements for germination and early seedling growth; protection from pests, insects, and diseases; and transplanting techniques (plastic bags, cuttings, bare root, use of root trainers). FUNDECOR does not use root trainers because of their high cost.

Tree growth and competition. The tolerance of selected species to shade and light is incompletely known. FUNDECOR is testing the response of some species to planting under varying densities of shade. The tolerance of some of the selected species to drought and/or poor drainage conditions is also unclear. Because of the limited information available on the species' response to competition for light and/or moisture, one farmer which the team visited had received conflicting advice on cleaning competing weeds. Little is known about inter-relationships between the selected species and other components of the ecosystems from which they come. Research now going on at OTS should contribute to the understanding of such relationships.

Neither FUNDECOR nor OTS has established tests to determine the response of the eight selected species to planting at various spacings or their response to thinning. FUNDECOR obtained DGF approval to establish plantations at spacings of 4 meters by 4 meters and 4 meters by 3 meters, rather than 3 meters by 3 meters, based on FUNDECOR's foresters' observations that the wider spacings would allow a commercial thinning 6 to 8 years after planting. With the narrower spacing a pre-commercial thinning is recommended 3 to 4 years after planting. Trials are needed to determine the growth, yield, and rotation length for each of the species at different spacings and thinning regimes.

The site and soil requirements of selected species and their selected seed sources are only partially known. FUNDECOR does not attempt to match seed source to planting site. Incorrect matching of species or provenance to site will also impact adversely on survival and growth rates.

Agro-forestry systems. Some native tree species have potential for use in agro-forestry systems and/or for the management of natural regeneration to establish secondary forests. Research is needed to develop recommended practices and to generate information necessary to carry out economic analyses of such practices.

Timber yield response. OTS has only collected a few years of growth and yield data. Data are not available for different soil and site conditions. Therefore, for most of the native species being used it is not possible to determine the optimal rotation length or the yield for a given rotation. Thus, accurate economic projections are not possible for most of the native species recommended by FUNDECOR. Economic analyses are based on projections of growth in the first few year after plantation establishment at the OTS research sites.

Past experience with native tree plantation establishment suggests the need to proceed with caution and for a monitoring system capable of quickly detecting changes in growth rates or disease and insect outbreaks. Species which perform well on one site sometimes stagnate under different site conditions in response to differences in drainage, soil Ph, the presence or absence of trace elements, etc. Monocultures, even when planted in small blocks, often create ideal conditions for disease or insect outbreaks. Within species, genetic variation can result in uncharacteristically slow growth or susceptibility to attack when site conditions of the seed source do not match those of the plantation. Research is needed to determine the yield of thinnings and the potential markets for thinnings.

Environmental impact. The impact of harvesting of plantations on soil fertility and soil physics and yields of second and third generation plantations and beyond is not known. On some tropical soils yields of exotic species plantations decline in later

rotations - probably due to declining soil fertility. In many tropical areas the majority of the nutrients on a given site are stored in the vegetation. When the vegetation is removed, much of the nutrients are removed.

Natural Forest Management Research

The natural forest management plans (really harvesting plans rather than management plans since they do not contain post-harvest silvicultural recommendations) prepared by FUNDECOR contractors are based on "gap theory" developed by OTS and TSC researchers and on research carried out by CATIE. While it is well established that natural regeneration in gaps maintains tropical forests, little is known about the growth and yield of forests which have been selectively logged to create artificial gaps or about how the size of the gap affects growth, species composition, and wildlife habitat.

Harvesting intensity. FUNDECOR does not know how often the natural forests in the ACCVC can be harvested, the optimal volume of harvests, how the density of seed trees affects natural regeneration, nor how these parameters vary with site. Without such information reliable analysis of the economics of natural forest management is not possible. Information on how harvesting affects the composition and structure of the forest is also needed for economic analysis and to determine the sustainability of natural forest management.

Alternative management approaches. The FORESTA project called for two systems of natural forest management - the selection method and the strip shelterwood method - to be used in the ACCVC. Since there is little experience with either of these methods anywhere in the tropics, data is not available to predict length of rotation or the volume of timber which can be removed or to carry out analyses of the economics of natural forest management. Budowski (n.d.) mentions that the strip shelterwood method has been used in Palcazu, Peru (in the USAID supported Central Selva project) where the presumed rotation length is 40 years and that the selection method has been introduced in Surinam with a 20 year rotation length.

Some suggest that forests which are selectively logged can be harvested as frequently as every 10 years. Budowski suggests that both methods, and a few variants, be tested in promising areas (areas where valuable species are most abundant and where the topography and road access are favorable) of the ACCVC. Unfortunately, Budowski, like the project design team, overlooks important socio-economic constraints (land tenure, fragmented holdings, absentee ownership, etc.) which may make it difficult to carry out such research or to implement the strip method anywhere in the ACCVC.

Post-harvest treatment. Research on post harvest treatments is also needed (Tschinkel, et. al., 1994). Such research will contribute to the financial and ecological sustainability of natural forest management by providing information which enables forest managers to influence the growth and structure of the forest, and the yield of future harvests.

Ecological impact. Research on the impact of forest harvesting on wildlife, especially on endangered species such as the green macaw, could help forest managers improve the wildlife habitat at the same time that they are harvesting timber (Tschinkel, et. al. 1994). Managing the forest for wildlife as well as timber products can contribute to the economic viability of natural forest management. Enhanced wildlife populations can contribute to the value of a property for ecotourism or for hunting of non-endangered species.

Modeling and planning. The First Central American Forestry Congress, in September, 1993, recognized the need for simplified natural forest management plans which address long term management planning rather than focussing on the harvesting process. FUNDECOR and others convinced the Congress to call on the Central American Tropical Forestry Action Plan to identify technical institutions to develop simplified models for management plans. As a result CATIE's Natural Forest Production Activity is developing model plans for broad-leaved forests (Tschinkel, et. al. 1994).

APPENDIX C

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